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THE DESCRIPTION and Use,

Of an Universal and Perpetual

Mathematical Instrument.

SHEWING

The most Expeditious and Exact Method of
solving all practical Questions in

ARITHMETICK, TRIGONOMETRY, NAVIGATION,
DYALLING, ASTRONOMY, &c.

VIZ.

Sun's Place,
— Right Ascension,
— Declination,
— Amplitude,
— Rising and Setting, and
Equation of Time.

Likewise

The Dominical Letter,
Cycle of the Sun,
Golden Number,

Epact,
Fix'd and Moveable Feasts
in both Accounts,
Terms and their Returns,
New and Full Moons,
Moon's Southing,
Time of High Water for
Thirty-four Havens,
With the Eclipses of the Sun
and Moon,
Conjunction of the Superior
and Transits of the two
Inferior Planets over the
Disk or Face of the Sun.

By BENJAMIN SCOTT.

L O N D O N :

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1733

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Patent Office

Washington, D.C.

February 1, 1900

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Dear Sir:

I have the honor to acknowledge the receipt of your letter of the 28th inst.

and in reply to inform you that the same has been forwarded to the proper authorities for their consideration.

I am, Sir, very respectfully,

Yours very truly,

[illegible signature]

Very truly yours,

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The Right * MONOURABLE

JOHN BOYLE,

EARL of

ORRERY.

My LORD,

MATHEMATICKS is universally esteem'd the brightest Accomplishment of Men of Learning; in which none have more remarkably distinguish'd themselves than your

your Lordship's *Ancestors*: For the most useful Instrument of this Noble Science took the Name of ORRERY from your Lordship's Learned and Illustrious Father, the Inventor thereof: And the Honourable ROBERT BOYLE, Esq; will always be remember'd, with Admiration, for his deep Discoveries in Natural and Experimental Philosophy, particularly for his Invention of the AIR PUMP; not to mention his extensive Charity towards Mankind, of which the annual Lectures establish'd for the Confirmation of Christianity, and his large Donations to encourage the Translations of Books into such Languages as would best promote so pious a Work, will remain everlasting Monuments.

As your Lordship inherits all the Ornaments of two such GREAT MEN, what additional Lustre may we not expect from you? The Encouragement you have thought fit to give to my present Design, is an Instance of that elegant

gant Taste with which your Lordship relishes these useful Studies. I wish the Performance may answer your Expectation, and entertain your Hours when it will not interfere with your Lordship's intentive Zeal for the Service of your Country.

THIS Instrument is universal, not only answering all practical Questions of the Mathematicks at one View, without the tedious Operations of Numbers; but also representing all the Seasons and Changes of the Year, &c. 'Tis needless to trouble your Lordship with an Enumeration of its Uses, or of this Book which fully explains them, since they both speak clearly for themselves.

BUT as your Lordship was pleased to encourage the Publication, I humbly offer it as a grateful Acknowledgment of the Honour done me: And that you may long live to perpetuate the Glory of your Noble Family, as a Patron of

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all

all useful Learning and Science, and as
a Shining Ornament to your Country,
is the humble and sincere Wish of,

My LORD,

Your LORDSHIP'S

Most Obedient, and

Most Humble Servant,

Benjamin Scott.



THE P R E F A C E.


HIS Preface is chiefly to inform the Reader of the many Advantages he may receive from a careful Perusal of the ensuing Work. As Mathematical Learning is justly esteemed, by all the Polite World, the Accomplishment of a fine Gentleman, it is hoped this New and Practical Instrument, intended for the Improvement of that Noble Science, will receive its deserved Encouragement. The Antients were curious for many Inventions: Architas made a Wooden Dove; Archimedes made a Sphere of Glass representing

senting the Motions and Appearances of the Heavenly Bodies ; and invented Engines with which he defended the City of Syracuse for three Years against Marcellus, the Roman General, by throwing Stones of 1200 lb. Weight into his Ships : Regiomontanus form'd a Wooden Eagle and an Iron Fly : Scalias, a Blacksmith made a Lock, Key, and Chain of Forty-three Links of Gold, which weigh'd but one Grain and a Half, and could easily be drawn by a Flea. These and many more Curiosities, which might be mentioned, were the Product of Mathematical Reasoning ; but none of their most accurate Inventions serv'd the Ends and Purposes of this Instrument.

THE Baron of Merchiston in Scotland, was the first Inventaer of Logarithms ; and our Countryman, Mr. Gunter, was the first who apply'd them to Lines graduated upon Wood : Afterwards Mr. Everard, in order to shorten the Operation, apply'd them to a Sliding-Rule ; but both these Inventions fall infinitely short of the Line of Numbers in this Instrument, because of its great Length. Besides the Conveniences and Advantages which accrue from the Length of this Line, here is also a perpetual Almanack for Old and New Style, and at one View may be seen all the Festivals,

The P R E F A C E. ix

Festivals, Terms, Tides, Eclipses, Conjunctions, Transits, &c. together with a Solution of all Questions in Practical Mathematicks (almost) by Inspection. And as this Instrument is universally useful, so is it ornamental for any Gentleman's Study; and after a little Practice will become very easy, by a careful Perusal of the following Book, which renders every Thing intelligible and plain to the meanest Capacity; the Terms of Art, made Use of in this Instrument, being explained; the Description of every Circle, with its Uses, being inserted; and Tables calculated with the utmost Care and Labour to compleat the Whole. Certainly nothing can excite the Mind more to the Study of the Mathematicks than to have correct Instruments, by which the most intricate Problems may be solved to as great Exactness as they can possibly be answered by tedious Operations.

BUT it may, perhaps, be objected, that such Instruments are not easily procured, and if they are too small, the Truth of a Problem cannot be found out. In answer to this we may remark, That this Instrument is so contrived, that any Question being proposed and put, a full and clear Answer may immediately be given, as the Practitioner will find on comparing the Examples wrought in
this

x The P R E F A C E.

this Book by the Assistance of this Instrument, with Calculations annexed to this Treatise. And as it is useful to Gentlemen who study the Mathematicks, so is it likewise to the Surveyor in taking his Distances ; to the Navigator in working his Traverses ; to the Astronomer in solving all Questions relating to the Sphere ; to the Dialist in calculating of Hour Lines upon all such Planes as have Centers ; and to Schools and Academies where Mathematical Lectures are read : For by this Instrument alone the Master may give the Pupil a clearer View of the Branches herein handled, than by any other Way or Method that can be proposed.

THIS it is hoped will encourage others to the Search of Instruments whereby an Altitude may be taken at Sea to a Second ; or to observe an Immersion or Emerision of Jupiter's Satellites to as great Exactness as if taken on Shore ; which would be of great Use to the Publick, and what would solve the Grand Problem, viz. The Longitude at Sea.

TO conclude, neither Time, Care, nor Cost have been spared to make this Instrument answer the Ends and Purposes for which it was designed ; and I cannot sufficiently express

The PREFACE. xi

press my Gratitude to that Noble Lord, who condescended to accept the Dedication of this Tract and Instrument; and also to the never to be forgotten Memory of the Illustrious and Honourable Mr. Robert Boyle, to whose great Sagacity, Learning, and Penetration, the Learned Part of the World are now, and for Ages to come, may continue to be indebted; which have added such Beauty to this Instrument as to make it universally Ornamental, as well as useful for all Studies: My Wishes therefore to the Readers and Encouragers of this Work are, that they may find as much Profit in using, as I have had Pleasure in compiling it.



THE

12 BENJAMIN SCOTT,

*At the MARINER and GLOBE, against
Exeter-Change, in the Strand,*

MAKES and Sells all Sorts of Mathematical Instruments in Silver, Brass, Ivory, and Wood, &c. performed according to the latest Improvements of Philosophers and Practicers of the several Mathematical Arts, whereby they are render'd most Neat, Portable, and Accurate for Expedition.

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*At the Hand and Pen, in Cock-Lane,
Shoreditch, are taught,*

ASTRONOMY, NAVIGATION, and the Use
of the GLOBES,

TH By CHARLES LEADBETTER.



A N
EXPLANATION
O F

The TERMS used in the following TREATISE.



Latitude, is the Height that the Sun, Moon, or Stars are above the Horizon at any Time of the Day or Night, reckoned in Degrees and Minutes.

Amplitude, is an Arch of the Horizon comprehended between the east and west Points thereof, and the Place on the Horizon where the Sun, Moon, or any Star rises or sets.

Angle, is the meeting of two Lines in a Point, which is best explain'd by the two Legs of the Sector moving upon the Center of the Instrument; for if the Legs be opened to any Distance, then the two Horse-hairs meeting in a Point, do make an

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Angle

Angle equal to that Distance unto which the Legs were opened, which may be measured by any concentrick Circle equally divided ; as for Instance, count the Degrees in the fifth Circle, or Circle of Signs, comprehended between the two Hairs, and that is the Quantity of the Angle sought.

Aquarius, a Water-bearer, represented in the Instrument by an old Man pouring out a Pitcher of Water ; in all astronomical Calculations it is the tenth Sign, unto which the Sun comes the 9th Day of *January*, and it is thus characterized ♒.

Aries, the Ram, (alias Tup) in the Instrument is engraved in the great Space between the third and fourth Circles ; is one of the twelve cœlestial Signs, and the first in order in the Zodiac ; but in all astronomical Calculations it is number'd with 0, unto which the Sun comes the 9th Day of *March*, making then our Days and Nights equal ; it is called the vernal Equinox, and is thus characterized ♈.

Artificial Numbers, Sines, Tangents, and Secants, are Numbers adapted purely to shorten the Work in Proportion, Trigonometry, &c. which in the Instrument are represented by the first, second, and third Circles.

Ascensional Difference, is the Difference between the right and oblique Ascension of the Sun, Moon, or Star, in Degrees upon the Equator, which reduced into Time, allowing 15°
to

to an Hour, &c. will always be equal to the Time between the Sun's rising and setting, and six o' Clock.

Astronomy, the Law of the Stars, is a Science that teaches us the Motions, Distances, and Magnitudes of the heavenly Bodies, with the Eclipses, &c.

Austral Signs, are the six last Signs of the Zodiack, viz. ♋, ♌, ♍, ♎, ♏, ♐.

Azimuths, are great Circles of the Sphere meeting in the Zenith and Nadir of your Habitation, and cutting the Horizon at right Angles, which are infinite.

Bissextile, Leap-Year, because every fourth Year the six Calends of *March* are twice repeated ; for every fourth Year the odd six Hours make one entire Day, which is placed in the *Julian* Calendar, next after the 24th Day of *February*, causing that Month to contain twenty-nine Days every fourth Year.

Boreal, or northern Signs, are these six, viz. ♈, ♉, ♊, ♋, ♌, ♍.

Callyopick Period, seventy-six Years.

Cancer, the Crab, the fourth Sign of the Zodiack, but third compleat in astronomical Calculation ; it is a tropical Sign, unto which the Sun comes the 10th of *June*, having then the greatest Declination, Meridian Altitude, and Amplitude.

Capricorn, the Goat mark'd thus, ♄, the 10th Sign in the Zodiack, a Cardinal, and the south tropical Sign, unto which when the Sun comes, which is on the 10th of *December*, he makes the longest Nights, and shortest Days to all on the north Side the Equator; the Sun has then the greatest south Declination and Amplitude, but the least meridian Altitude to all northern Inhabitants, but to the southern just the contrary.

Co-Sine, *Co-Tangent*, and *Co-Secant*, are so many Degrees as any, wants of 90° .

Cycle of the Sun, is a Revolution of twenty-eight Years, in which Time the dominical Letters are the same they were twenty-eight Years before.

Cycle of the Moon, is a Revolution of nineteen Years, in which Time the Conjunctions and Aspects of the Sun and Moon are near the same they were nineteen Years before: It is also called the Prime, or Golden Number; and four of these Revolutions make up the callippick Period, equal to seventy-six Years; in which Time the Aspects of the Luminaries come to a more perfect Degree of Exactness.

Declination of the Sun, Moon, or Stars, is their Distance from the Equinoctial towards either Pole in Degrees and Minutes: The Sun's greatest Declination is $23^{\circ} \frac{1}{2}$, equal to the Obliquity of the Ecliptick.

Depres-

Depression of the Pole, is so many Degrees as you travel or sail towards the Equator from either Pole ; you are said to depress the Pole so much, because it seems lower to you or nearer to your Horizon.

Degree, is the 360th Part of any Circle, or the 30th Part of a Sign, mark'd °.

Digit, is the twelfth Part of the Sun or Moon's Diameter.

Dominical Letter, or Lord's Day Letter, is one of the first seven of the Alphabet, whereof every common Year has one, and every Leap-Year two, by which the Sundays are marked throughout the Year in Almanacks ; and Tab. I. in the Instrument shows the dominical Letter for any Year by Inspection.

Ecliptick, is one of the six great Circles of the Sphere, intersecting the Equinoctial in the two opposite Points *Aries* and *Libra*, making an Angle therewith of $23^{\circ} \frac{1}{2}$, called the Obliquity of the Ecliptick, equal to the Sun's greatest Declination : In this Circle, according to Appearance, the Sun is always found ; it is divided into twelve equal Parts, called Signs, and every Sign into 30° , every Degree into $60'$ and each Minute into $60''$, &c. Always in or near this Line (Circle) are the Eclipses of the Luminaries made, from whence it takes its Name : this Circle also intersects the two Tropicks of *Cancer* and *Capricorn*.

Elevation of the Pole, is an Arch of the Meridian comprehended between the Pole and the Horizon, which is always equal to the Arch of the Meridian contained between the Zenith and Equinoctial, these being equal, or the same with the Latitude of the Place.

Epact, is the Difference between the common solar and lunar Year; for the first contains 365, and the latter 354; their Difference is 11, and is called the Epact, for so much doth the Moon gain of the Sun every Year, which in nineteen Years Time finishes one Revolution; that is, the Full and Change of the Moon, &c. are made on the same Day that they were nineteen Years before.

Equation of Time, or natural Days, was never rightly understood, till this our Age: It was first demonstrated by the famous *Street*, and next by the Reverend and Learned Mr. *Flamsteed*. It consists of two Parts; the first is nothing but the Difference the Sun's apparent Longitude and right Ascension; which Difference is occasioned by the Obliquity of the Ecliptick, and being turned into Time will give the first Part of the Equation, which in the first and third Quadrants is to be added to the equal Time, because there the Sun's right Ascension is less than the Longitude or Place in the Ecliptick; but in the second and fourth Quadrants the same Equation is to be subtracted from the equal Time, to make it apparent, because there the right Ascension exceeds the long.

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The second Part of the Equation depends on the Earth's Eccentricity and mean Anomaly ; for all the Time the Sun apparently is moving from his Apogæon to the Perigæon, which is from the 18th of *June* to the 18th of *December*, the mean Place goeth before the true ; therefore the Equation of the Eccentric being reduced into Time must be added to the equal Time to make it apparent, because of the Earth's Rotation upon its own Axis : But while the Earth (or apparently the Sun) is moving from the Perigæon to the Apogæon, that is, the last six Signs of mean Anomaly, from the 18th Day of *December* to the 18th Day of *June*, here, I say, the true Place goes before the mean ; so that the Equation of the Eccentric being reduced into Time, and subtracted from the equal Time, will give the apparent, & *contra*, because of the Earth's diurnal Motion from West to East. Now the absolute Equation of natural Days is compounded of the two Parts above-mentioned ; for if they both add, or both subtract, then their Sum, otherwise their Difference is the absolute Equation of Time, which is placed in the tenth Circle in the Instrument over-against every Day of the Month.

Equinoctial, in the Heaven, or Equator on the Earth, is that great Circle of the Sphere, whose Poles are the Artick and Antartick Poles of the World ; it divides the Globe into two equal Hemispheres, *viz.* North and South, and passes through the East and West Points of the Horizon ; and at the Meridian it is always raised as much above the Horizon as is the Comple-

ment of the Latitude of the Place of Habitation, or equal to the Arch of the Meridian, which is contained between the Zenith and the elevated Pole ; every 15° of this Circle is equal to one Hour in Time, to which Circles when the Sun, Moon, or Star comes, they have then neither Declination nor Amplitude, which is on the 9th of *March*, and the 12th of *September* ; the Sun then entring *Aries* and *Libra* makes the vernal and autumnal Equinoxes, the Days and Nights being then equal all the World over.

Flux and Reflux of the Sea, or the ebbing and flowing thereof ; these you have in the Instrument in the nineteenth Circle, which is the same with the Tides, or Time of high Water.

Finitor, is the same with Horizon, which see.

Focus, the Orbs of the Planets are Ellipses, and every Ellipsis has two Focii or Navel-Points, which are the Centers by which the Ellipsis is drawn : In the copernican System the Sun is fixed upon the lower Focus, on which the apparent Motion is made, and the equal Motion is made upon the upper Focus.

Gemini, the Twins, the third Sign in the Zodiac, but in Number the second in all astronomical Calculations, to which the Sun comes the 10th Day of *May*, making then no Night but Twilight at *London* ; it is thus characterized II.

Golden Number, is the same with the Cycle of the Moon, which see.

Gregorian Year, is the Reformation of the Calendar by Pope Gregory XIII. in the Year 1582, and is now in this Age, eleven Days before the old Stile used by us in *England*, and will continue so till the Year 1800, and then will be twelve Days before us, and so on every hundred Years they will gain one Day.

Horizon, is one of the six great Circles of the Sphere, it divides the Heavens and the Earth into two equal Parts, or Hemispheres, and is the Boundary of Day and Night, unto which, when the Sun, Moon, and Stars apparently come, they seem to rise and set : Every particular Person upon Earth has a particular Horizon, the Poles of which are the Zenith and Nadir.

Index, the two flat Pieces of Brass that move upon the Center of the Instrument marked with the Letters A and B, for Distinction sake ; and the Figures upon each of them are the Number of the concentrick Circles in the Instrument, which is a ready Guide for you to any Circle at Pleasure.

Julian Year, or Account, is the old Account of the Year instituted by *Julius Cæsar*, which to this Day is used in *England*, and in all Protestant Countries ; it is called the old Stile in Contradiction to the new Account, framed by Pope Gregory XIII. This *Julian Year* contains 365 Days six Hours, which said six Hours in four
Years

Years make one Day, and is placed in the Calendar next after the 24th of *February*, making that Month to consist of 29 Days every fourth Year, which is called Leap-Year, because from that Day to the End of the Year, the Days of the Month go forward from *Saturday* to *Monday*, &c.

Julian Period, is a Cycle of 7980 Years, produced by the continual Multiplication of the three Cycles, viz. the Solar, the Lunar, and the Indiction, one into another. *Julius Scaliger* fixed the Beginning of this Period 764 Years before the Creation of the World. It is of good Use for Astronomers and Chronologers.

Jupiter, is the highest Planet, except *Saturn*, in the planetary System; he performs one Revolution in 11 Years 314 Days 12 Hours and 20', his mean diurnal Motion is 4' 59", his Orbit makes an Angle with the Ecliptick of $1^{\circ} 20''$: this Planet has four Satellites moving round him; he is 577 Times greater than our Earth: Every 19 Years and 312 Days this Planet with *Saturn* make their mean Conjunction, being advanced further in the Zodiack by 8 H. $2^{\circ} 48'$, their true Conjunctions you have in the Instrument till the Year 1821 inclusive.

Latitude of a Star, is the Distance of the Star from the Ecliptick either North or South: In Geography it is the Distance of your Habitation from the Equator North or South, which is the same with the Height of the Pole above the Horizon.

Longitude

Longitude of a Star, is its Place in the Zodiac, reckoning from the Beginning of *Aries*. In Geography it is the Distance of your Habitation, either East or West, from any other Meridian, reckoned in Degrees upon the Equator.

Leap-Year, the same with Bissextile, which see.

Leo, the Lyon, the fifth Sign in the Zodiac, thus characterized ♌ , into which the Sun comes the 12th Day of July, whence in the Latitude of *London* then begins to be perfect Night.

Libra, the Balance, the seventh Sign in the Zodiac, characterized thus ♎ , unto which the Sun comes the 12th Day of *September*, making the autumnal Equinox.

Mars, the Name of one of the Planets, which moves round the Sun in an Orb between that of the Earth and *Jupiter*; he performs his Revolution in 1 Year 321 Days 23 Hours and 27 Minutes; his mean diurnal Motion is $31^{\circ} 27''$; his Orbit makes an Angle with the Ecliptick of $1^{\circ} 52'$, and he is 15 Times less than our Earth.

Mercury, the Name of one of the Planets, whose Orb is next unto the Sun, for that Reason he is seldom seen; he is never more than 29° from the Sun; he performs his Revolution in 87 Days 23 Hours 16 Seconds: The Inclination of his Orbit with the Ecliptick is $6^{\circ} 54'$ and

and he is twenty-seven Times less than our Earth. In the Instrument you have the Times of his transiting the Sun's Disk for this Century, which always happens when he is Retrograde, and at the Conjunction with the Sun, when his Latitude is less than the Sun's apparent Semidiameter.

Meridian, is one of the six great Circles of the Sphere, exactly in the Middle between East and West, unto which when the Sun comes it has then the greatest Altitude that he can have that Day.

Metonick Year, the same with the Cycle of the Moon, which see.

Minute, is the 60th Part of a Degree, and is marked thus '.

Moon, is one of the seven Planets, the lowest and nearest of all to our Earth; her periodical Revolution is 27 Days 7 Hours 43 Minutes and 7 Seconds; her Orb intersects the Ecliptick in two opposite Points, making an Angle therewith of $5^{\circ} 18'$; the Time and Quantity of her Eclipses you have by the Instrument, until the Year 1750.

Nadir, is the Point in the Heavens seemingly under your Feet.

Nape-Tide, are those that happen at the Quarters of the Moon, which are the least of all; because then the Luminaries are farthest removed

ved asunder in respect of Attraction, causes the Sea then to swell the least.

Nocturnal Arch, is the Time any heavenly Body is under the Horizon, which in the Sun is always equal to the double of his Rising.

Nodes, in Astronomy, are the Intersections of the Orbs of the Planets with the Earth's Orb or Ecliptick.

Northern Signs, are those six in which the Sun when he comes has both North Declination and Amplitude; and they are *Aries, Taurus, Gemini, Cancer, Leo, Virgo*; in which the Sun continues from the 9th of *March* to the 12th of *September*.

Number of Direction; this Number was invented on Purpose to find the moveable Feasts by; it can never exceed 35, because so many Days there are just from *March 21* to *April 25* inclusive, which are the Bounds or Limits of *Easter*, because that Feast can never fall lower than the first, nor higher than the last. We have a Rule to find this Number arithmetically; but in the Instrument, Table III. you may find it by Inspection for ever.

Oblique Ascension, is that Degree and Minute of the Equinoctial, which rises with the Center of the Sun or Star, or with any Part of the Heavens in an oblique Sphere.

Oblique

Oblique Descension, is that Part of the Equinoctial that sets with the Sun, Moon, or Star, or with any Part of the Heaven in an oblique Sphere.

Pisces, is the twelfth and last Sign of the Zodiac, characterized thus ♓; in the Instrument represented by two Fishes tied together by their Tails: The Sun enters this Sign the 8th Day of February.

Planets, are the errattick or wandering Stars; they are not like the fixed Stars, for these two Reasons, 1st, Because they are not in the same Position to one another; and 2^{dly}, Because they never twinkle as the fixed Stars do: of these there are seven, which are placed in the Instrument, viz. the Sun, and Moon's Eclipses; *Saturn*, *Jupiter*, and *Mars*'s Conjunctions; *Venus* and *Mercury*'s Transits over the Sun's Disk.

Quarters of the Moon, are the middle Points of her Orb, between the Conjunction and Opposition, or when the Luminaries are 90° asunder, called the first and last Quarter.

Return, in Law, hath two several Applications; the one is the Return of Writs by Sheriffs and Bailiffs, which is only a Certificate made to the Court of that which he hath done, touching the Execution of their Writ directed to him; and this among the Civilians is termed *Certificatorium*: Of Returns in this Signification speaks the Statute of *Westminster*, 2. Chap. 39. So is the

the Return of a Commission, a Certificate or Answer to the Court of that which is done by the Commissioners, Sheriffs, or other to whom such Writs, Commissions, Precepts, or Mandates are directed. Also certain Days in every Term are called Returns, or Days of Bank; and so *Hillary* Term hath four Returns, viz.

Octabis Hillarii, 8 Days, Jan. 20.

Quindena Hillarii, 15 Days, Jan. 27.

Crastino Purificationis, February 3.

Octabis Purificationis, February 9, that is eight Days after the Purification.

Easter Term hath five Returns, viz.

Quindena Pasche, is 15 Days after *Easter*.

Tres Pasche, is three Weeks after *Easter*.

Mense Pasche, is a Month after *Easter*.

Quinque Pasche, is five Weeks after *Easter*.

Crastino Ascensionis Domini, is the Morrow next after *Ascension Day*.

Trinity Term hath four Returns, viz.

Crastino Trinitatis, being the Morrow after *Trinity Sunday*.

Octabis Trinitatis, being eight Days after *Trinity Sunday*.

Quindena Trinitatis, is 15 Days after *Trinity Sunday*.

Tres Trinitatis, is three Weeks after *Trinity Sunday*.

Lastly,

Lastly, *Michaelmas Term* has six Returns, viz.

Tres Michaelis, is three Weeks after *Michaelmas*, October 20.

Mense Michaelis, is a Month after *Michaelmas*, October 27.

Crastino Animarum, is five Weeks after *Michaelmas*, November 3 ; or the Day after *All-Souls*.

Crastino Martini, is the Morrow next after St. Martin, November 12.

Octabis Martini, is eight Days after St. Martin, November 18.

Quindena Martini, is 15 Days after St. Martin, November 25.

The other Application of this Word is in case of a Replevin; for if a Man distrain Cattle for Rent, &c. and afterward avow or justify his Act, so as it be found lawful, the Cattle before delivered unto him that was distrained, upon Security given to follow the Action, shall now be returned to him that distrained them.

Right Ascension of the Sun, Moon, or Star, is that Degree of the Equinoctial counted from the Beginning of *Aries* which rises with it in a right Sphere : Or it is that Degree and Minute of the Equinoctial which comes to the Meridian with the Sun Moon, or Star in an oblique Sphere; every 15° is equal to 1 Hour, and 360° to 24. See the Table in Page .

Rising

Rising of the Sun, Moon, or Star, is their appearing above the eastern Horizon. The Time of the Sun's rising in all Places, is always equal to half the Length of the Night.

Sagittarius, the Archer, or Bowman, thus characterized ♐ : It is the ninth Sign in the Zodiack, the Sun enters it about the 12th day of *November*.

Saturn, the highest Planet in the *System*; he performs his Revolution in 29 Years, 167 days 22 hours, 57": He is 298 Times greater than our Earth. In the Instrument you have his Conjunction with *Jupiter*, and is thus characterized ♄.

Scorpio, the Scorpion, is the 8th Sign in the Zodiack, thus characterized ♏, into which the Sun enters the 13th Day of *October*.

Setting of the heavenly Bodies, are their going down in the western Horizon. Hence the Time of Sun-setting in any Latitude is always equal to half the Length of the Day.

Signs, are the 12 Signs of the Zodiack, viz. *Aries* ♈, *Taurus* ♉, *Gemini* ♊, *Cancer* ♋, *Leo* ♌, *Virgo* ♍, *Libra* ♎, *Scorpio* ♏, *Sagittary* ♐, *Capricorn* ♑, *Aquarius* ♒, *Pisces* ♓.

Southern Signs, are *Libra*, *Scorpio*, *Sagittary*, *Capricorn*, *Aquarius*, *Pisces*; because while the Sun continues in them, which is from *September* the 12th, to *March* the 9th following,

ing, he has both South Declination and Amplitude.

Spring-Tides, are made near the New and Full Moons; the Tides are higher than when the Moon is in the Quarters, and the Equinoctial Spring Tides are the greatest of all.

Sun, according to Appearance, is one of the seven Planets, and gives Light to the other fix; his mean diurnal Motion is $59^{\circ} 8''$; he always moves in the Ecliptick, in which he performs one Revolution in 365 Days 5 Hours $49' 23''$, and is 258309 Times greater than our Earth: All his Eclipses that will be visible at *London*, you have in the Instrument till the Year 1750.

Taurus, the Bull, the second Sign in the Zodiac, marked thus ☉, into this Sign the Sun enters about the 9th Day of *April*.

Terms, at *Westminster*, there be four every Year, during which Time Matters of Justice are dispatched: Two of which are fixed, *viz. Hilary*, and *Michaelmas*, that is, begin and end on certain Days of the Month, which, in the Instrument, you will find placed against their proper Days in *January*, *February*, *October*, and *November*; the other two, which are called *Easter-Term* and *Trinity-Term*, are moveable; according as *Easter* falls, so they fall high or low, ever keeping at a certain Distance from *Easter*, &c. These two in the Instrument are placed in the Segments of Circles amongst the moveable Feasts.

Tides,

Tides. See Nape and Spring-Tides.

Time begins at Noon.

Venus, one of the seven Planets, thus characterized ♀; she moves in an Orb, between that of the Earth and *Mercury*, and performs her Revolution in 224 Days 16 Hours and 49'; she is a true Attendant of the Sun, for she is never more than 48° from him. When this Planet will be seen in the Sun, the Instrument will inform you till the Year 1769. The Orbit of this Planet makes an Angle with the Ecliptick of $3^{\circ} 24'$ only; but for all that, she has sometimes near 9° of Latitude; she is three times lesser than our Earth.

Virgo, is one of the 12 Signs of the Zodiack, being the sixth in order, marked thus ♍, and in the Instrument engraved as a beautiful Maid, unto which the Sun comes the 12th or 13th Day of *August*.

Year. See Julian Year.

Zenith, or *Vertex*, is that Place in the Heavens right over one's Head, being diametrically opposite unto the *Nadir*, and is always 90° distant every Way from the Horizon; and here note, that the Arch of the Meridian, between the *Zenith* and *Equinoctial*, is always equal to the Arch of the Meridian between the Horizon and the elevated Pole, which are the same with the Latitude of the Place.

Zodiack, is a Zone or Girdle, surrounding the Heavens; it is in Breadth 18° , the Middle of which is the Ecliptick, or apparent Way of the Sun, in which are drawn the twelve Signs as above described.



ADE-



A
DESCRIPTION
OF THE
INSTRUMENT.



T consists of 20 Circles, 12 Segments of Circles, and three Tables.

1. In the first Circle is graduated the Line of Numbers, which is the same with that Line commonly known by the Name of *Gunter's-Line*: but this has the Advantage of all others, because of its Length, which in Circumference is 58, 43 Inches; for its Diameter is 18 6 Inches, which is almost 5 Foot in length, if stretched out: By this Line is performed Multiplication, Division, the Rule of Proportion, and Extraction of Roots. But first you are to observe the Numeration upon this Circle, which is thus: The Figure 1 at the Beginning of the Circle (where you see the Word Numbers) may either be 01, or 10 or 100, or 1000, &c. then will the other 1 at the opposite Part of the Circle (for it is a double Radius) be 1, 10, 100, 1000, 10000, encreasing all

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round in a ten-fold Proportion ; and the like may be said of the intermediate Divisions ; for,

If the Figure at End be	.1	The large Divi- ons will be	.01	And the next Di- vifion will be	.001
	1.0		.1		.01
	10.		1.		.1
	100.		10.		1.
	1000.		100.		10.
	10000.		1000.		100.
	100000.		10000.		1000.

These Divisions from 1 to 3 in each Radius, are each divided into 10, but from 3 to the End of the Radius, the Primes are divided into 5, and those tenths each into 5, so each one of those smaller Divisions are .02, &c.

To multiply by these Numbers.

Rule. Set the Leg A (of the Sector) to Unity, on the Circle of Numbers, there stay it, and move the Leg B to either Sector ; as the Sector now stands, move the Leg A to the other Sector, and the Hair of the Leg B will cut the Product.

Example.

Multiply	7.3	by	20.2	Products	147.5
	5.7		13.5		77.0
	9.4		7.6		71.4
	4.2		16.9		71.0
	6.8		13.1		89.1
	14.3		15.7		224.5
	1.5		33.8		50.7
	18.6		6.2		115.3
	3.3		25.4		83.8
	2.9		12.9		37.4
	8.8		8.8		77.4

3. Division by the Circle of Numbers.

Rule. Set the Hair of the Leg A to Unity, and the Hair of the Leg B to the Divisor; here screw the Sector fast, and move the Hair of the Leg B to the Dividend; the Hair of the Leg A will cut the Quotient. *Example.*

Divide	147.5	by	7.3	Quotient	20.2
	77.0		5.7		13.5
	71.4		9.4		7.6
	71.0		4.2		16.9
	89.1		6.8		13.1
	224.5		14.3		15.7
	50.7		1.5		33.8
	115.3		18.6		6.2
	83.8		3.3		25.4
	37.4		2.9		12.9
	77.4		8.8		8.8

4. The single Rule of Threes direct, or continual Proportion upon this Circle of Numbers. *Rule.*

Set the Hair of the Leg A to the first Term, here hold it fast, and move the Hair of the Leg B to the second Term; here screw the Leg fast, and move the Leg A to the third Term, then will the Hair of the Leg B cut the fourth proportional Term sought. *Example.*

If 2 Yards of Cloth cost 4 s. what will 6 Yards cost at that Rate?

If you work according to the Rule above, you will find the Answer to be 12 Yards: For, as
2 : 4 :: 6 : 12.

C. 4

Secondly,

Secondly, If 15 Yards of any thing cost 10 s. what will $5\frac{1}{2}$ cost?

Ans. 3^o 66, which Fraction 66 of a Shilling is = to 8 d.

Note, You must always be sure to have special Regard to the Numeration upon the Circle, as directed above, otherwise you may mistake an Integer for a Fraction, or 1 for 10, &c. which will cause great Errors.

V. To extract the Square Root upon the Circle of Numbers.

Rule. Set the Hair A to Unity, and open the other Leg till that opening be just half the Distance between Unity, and the given Square to be extracted; then will the Hair B cut the Root of that Square: Then for Proof of your Work, move this Opening of the Legs until the Hair A cut the Root above found, for then will the Hair B also cut the given Square. *Example*.

What's the square Root of 9?

I set the Hair A to Unity, (or 1) and move the Leg B till it is just half the Distance between that and the given Square 9, and then I find it falls upon 3, the Root sought, and by the same Method I find the Square.

$$\text{Root of } \left\{ \begin{array}{c} 16 \\ 25 \\ 36 \\ 49 \\ 64 \\ 81 \\ 144 \end{array} \right\} \text{ to be } \left\{ \begin{array}{c} 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 12 \end{array} \right.$$

VI. To Extract the Cube Root by the Circle of Numbers.

Rule. Having found the given Cube upon the Circle, set the Hair A to Unity, there stay it, and move the Leg B until it is exact $\frac{1}{3}$ of the Distance between 1 where the Hair A resteth, and the given Cube. Now, I say, the Hair B cuts the Root sought. *Example.*

What's the Cube Root of 1728?

I set the Hair A to Unity at the Top, (but now I call that 1, 1000, from which I number my Cube) and divides the Space from Unity to 1728 into three equal Parts, and the Hair B doth then fall upon 12, the Root sought; And after the same Manner do I find the Cube.

Root of	{	8000	}	to be	{	20
		15625				25
		27000				30
		45499293				357
		9869198625				2145

Description and Use of the Circle of Sines and Secants.

The Line (or rather Circle) of Sines is taken from the Tables of Artificial Sines, which you have in most Books of the Mathematicks: It begins with 1, and is numbred round to the right Hand with 2, 3, 4, &c. to 90°, which are Degrees; every Degree of which from 1 to 5 inclu-
five

five are divided into 60 unequal Parts, called Minutes : But the Degrees from 5 to 10 inclusive are divided into every two Minutes, from 10 to 30; every Degree is divided into 5 Minutes, that is, every Division thereof is 5 Minutes; from 30 to 40°, every Division there is 10 Minutes; from 40° to 60 Degrees, every Division is 15 Minutes; from 60 to 70 Degrees, every Division is 30 Minutes; from 70 to 80 Degrees, every Division is one Degree: from 80 to 90 Degrees, every Division is 2 Degrees.

The double Figures which are placed with each Degree of the Sines, are Co-Sines, which serve here for Secants, because that the Co-Sine, or Sine Complement, taken from the double Radius, there remains the Secant of the same Arch. Whole Divisions are the same as in the Sines above-mentioned.

The Use of this Circle of Sines in Spherick Trigonometry, the Doctrine of the Sphere, Geography, Dialling, &c.

First, In the Spherick Triangle, right angled at B, there are given $\angle C 40^\circ$, and the Angle at C $25^\circ 30'$, to find $\angle B$.

OPERATION.



Set the Hair B to Radius or Sine of 90° , there hold it, and bring the Hair A to the Sine 40° ; screw this Opening fast, and move the Sector until the Hair B cut the given Angle C $25^\circ 30'$, then

then doth the Hair A cut, $16^{\circ} 4'$, the fourth proportional Sine sought.

Secondly, *Its Use in Geography, two Places, viz. London and Nipcho, both in the Latitude of $51^{\circ} 32'$ N. and differing in Longitude 116° , I demand their Distance in English Miles.*

ANALOGY.

As the Radius, or whole Sine of 90°
Is to the Sine Complement of the given Latitude, or Distance between the Zenith and Pole,

So is the Sine of half the Difference of Longitude,

To the Sine of half their Distance in the Arch of a great Circle.

OPERATION.

Set the Hair B to the Sine of 90 , and the Hair A to the Sine Complement of the given Latitude $38^{\circ} 28'$; move this Opening until the Hair B cut the Half of the given Difference of Longitude $38^{\circ} 15'$, and then doth the Hair A cut the Sine of $31^{\circ} 56'$, which doubled is $63^{\circ} 52'$, which multiplied by $69\frac{1}{4}$ the Miles in one Degree, gives $4430\frac{1}{4}$ English Miles, the Distance sought.

Thirdly,

Thirdly, *The Use of the Line of Sines in the Doctrine of the Sphere.*

Let it be required to find the Sun's Declination the 9th Day of *April*, or the 12th of *August*, the 12th of *October*, or the 7th of *February*; all which Days the Sun entreth γ , III , II , and $\times$ being 30° distant from the Equinoctial Points γ and III , which with the Obliquity of the Ecliptick $23^\circ 30'$ are given, to find the Declination that the Sun has then.

ANALOGY.

As the Radius, or whole Sine of 90°
Is to the Sine of the Sun's Distance from the
next Equinoctial Point γ or III ,
So is the Sine of the Obliquity of the Ecliptick,
or greatest Declination,
To the Sine of the Declination sought.

OPERATION.

Set the Hair of the Leg B to the Sine 90° , and the Hair A to the Sine of 30° , move this Opening of the Sector, until the Hair B cut the Sine of $23^\circ \frac{1}{2}$, the Sun's greatest Declination, and then the Hair A will cut $11^\circ \frac{1}{2}$ in the same Circle of Sines, which is the Sun's Declination then, and is North on the two first Days mentioned, and South on the two last: After the same Manner may the Declination be found in any other Point of the Ecliptick.

Secondly,

Secondly, *For the Sun's Amplitude.*

Example, What is the greatest Amplitude the Sun can have at *London*; this is when he toucheth the Tropicks of *Cancer* and *Capricorn*?

ANALOGY.

As the Sine Complement of the Latitude
 $38^{\circ} 28'$
 Is to the Radius, or Sine of 90 ,
 So is the Sine of the Declination
 To the Sine of the Amplitude.

OPERATION.

Set the Leg A to the Sine of $38^{\circ} 28'$, and the Hair B to the Sine of 90 ; then move this Opening of the Sector, till the Hair A cut the Sine of $23^{\circ} \frac{1}{2}$, then will the Hair B cut the Sine of $39^{\circ} 52'$, which is the Sun's Amplitude when he is in either Tropick.

Thirdly, *To find the Sun's Altitude when he is due East or West at London.*

Example, What Altitude will the Sun have the 22d Day of *April*, at 51' past 6 in the Morning, or at 9' past 5 in the Afternoon, at which Times the Sun is due East and West?

ANA-

ANALOGY.

As the Sine of the Latitude,
Is to Radius, or Sine of 90° ,
So is the Sine of the Declination
To the Sine of the Altitude.

Note, This is only of Use from the 9th of *March* to the 12th of *September*, that is, while the Sun is in Northern Signs: But by the same Method you may find the Sun's Depressi^on under the Horizon, when he comes to the East and West Azimuths, or is under the East and West Points of the Compass.

OPERATION.

Set the Hair of the Leg A to the Sine of the given Latitude $51^\circ 32'$, and the Hair B to the Sine of 9° ; then move this Opening that the Hair A may cut the Declination which the Sun has on the 22d Day of *April* $15^\circ 32'$, and then doth the Hair B cut the Sine of 20° , which is the Altitude that the Sun hath at the given Time.

Fourthly, To find the Sun's Altitude at 6 o'Clock in the Morning or Evening, when the Sun is in Northern Signs, or his Depressi^on at that time when he is in the six Southern Signs.

Example. What Altitude has the Sun on *April* the 22d, when his Declination is $15^\circ 32'$ North at *London*.

ANALOGY.

As the Radius, or Sine of 90
 Is to the Sine of the Latitude $51^{\circ} 32'$
 So is the Sine of the Declination $15^{\circ} 32'$
 To the Sine of the Sun's Altitude sought,

OPERATION.

Bring the Hair B to the Sine of 90 , and the Hair A to the Sine of $51^{\circ} 32'$, move this Opening of the Sector till the Hair B cut the Sine of the Declination $15^{\circ} 32'$, then doth the Hair A cut the Sun's Altitude, at that time which is $12^{\circ} 6'$, and so high is the Sun at 6 o'Clock, at the given Time and Place. And so likewise on *October* 24th, or *January* 26th, when the Sun has $15^{\circ} 32'$ South Declination, at 6 o'Clock he will be $12^{\circ} 6'$ below the Horizon. But at *Rome*, whose Latitude is $41^{\circ} 50'$ N. on those Days, the Sun's Altitude and Depression at 6 o'Clock will be $10^{\circ} 17'$, and so for any other Place in the known World, you may expeditiously find the same.

Lastly, To find the Altitude of the Sun any Hour of the Day, when he is in the Equinoctial.

Example. Let it be required to find the Sun's Altitude on *March* the 9th, or *September* the 12th, when he is in the Equinoctial, and has then no Declination in the Latitude of *London*, at 9 o'Clock in the Morning, or 3 in the Afternoon.

ANALOGY.

As the Radius, or Sine of 90
 Is to the Sine of the Complement of the Latitude 38, 28,
 So is the Sine of the Sun's Distance from the
 Hour of 6,
 To the Sine of the Altitude sought.

OPERATION.

Set the Hair B to the Sine of 90, and the Hair A to the Sine of the Complement of the Latitude of *London* 38° 28'; move this Opening that the Hair B cut 45° the Sine of the given Time 3 Hours from 6 o'Clock, and then doth the Hair A cut the Sine of 26° 6', and such is the Sun's Altitude at 9 in the Morning, or 3 in the Afternoon at the given Time and Place above-mentioned.

Note, That every Hour in Time is equal to 15° in the Equator. See the Table in pag. and the Word *Equinoctial*.

Description and Use of the third Circle, entitled Tangents.

This Circle is taken from the Table of Artificial Tangents, which you will find in most Mathematical Books, and begins with 1, and so is number'd all round towards the right Hand with 2, 3, 4, 5, &c. to 45°, and back again with 46, 47, 48, &c. to 89; which stands with 1 Degree in a small Character. The Numeration upon this Circle of Tangents is thus, *viz.*

From

From $\left\{ \begin{array}{l} 1^{\circ} \text{ to } 5^{\circ} \\ 5 \text{ to } 10 \\ 10 \text{ to } 45 \end{array} \right\}$ every Division is $\left\{ \begin{array}{l} 1 \text{ Minute} \\ 2 \text{ Min.} \\ 5 \text{ Min.} \end{array} \right.$

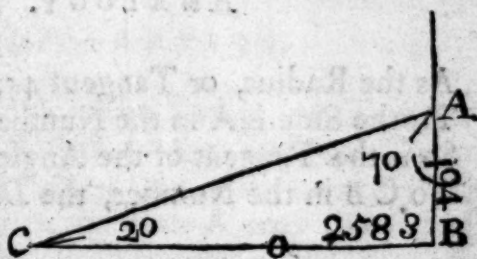
And then back again,

From $\left\{ \begin{array}{l} 45^{\circ} \text{ to } 80^{\circ} \\ 80 \text{ to } 85 \\ 85 \text{ to } 89 \end{array} \right\}$ every Division is $\left\{ \begin{array}{l} 5 \\ 2 \\ 1 \end{array} \right.$

Now having described the Number, Sines, Secants and Tangents, I shall next shew their joint Use, which are universal in all Parts of the Mathematicks; the Numbers and Sines may be used alone, as I have shewed above, but the Secants and Tangents must be used jointly with the other, *viz.* with the Numbers and Sines as I shall now shew,

And first, in plain Trigonometry, where I shall apply it in taking of Heights and Distances, &c.

Admit I am on the Top of *St. Paul's, London*, whose Height is 94 Yards, and there with a Quadrant I observe a Place towards *Hamstead*, and takes the Angle BAC, and finds it to be 70° , I demand how far the Place seen is from the Base of my standing at B, *viz.* the Side CB is required.



First, By the Sines and Numbers.

D

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ANALOGY.

As the Sine of the Angle C,
To the Height BA on the Circle of Numbers,
So is the Sine of the Angle A,
To the Distance CB.

OPERATION.

Set the Hair A to the Sine 20° , and the Hair B to 94 in the Circle of Numbers; move this Opening of the Sector forward, towards the right Hand, until the Hair A cut the Sine 70° , then will the Hair B cut 258.3 in the Numbers towards the right Hand, which are Yards, the Distance required.

Note, The first Figure 2 in the Numbers towards the right Hand, in this Case, is 200, and every grand Division next is 10, and every Sub-division is one Unite.

Secondly, By the Tangents and Numbers.

ANALOGY.

As the Radius, or Tangent 45° ,
To the Side BA in the Numbers,
So is the Tangent of the Angle A,
To CB in the Number, the Distance sought.

OPERATION.

Set the Hair B to the Tangent 45° , and the Hair A to the Tangent 70° ; move this Opening for-

forward, till the Hair A cut 94 in the Numbers, then doth the Hair B cut 258.3 in the Numbers, the Distance sought.

2. The Use of the Numbers, Sines, Tangents, and Secants in Plain-Sailing.

Example, Admit you sail away N.E. by N. from $48^{\circ} 12'$ N. Latitude, till your Departure be 52 Miles, I demand the Distance run, and Difference of Latitude.

First, For the Difference of Latitude, $a b$.



ANALOGY.

As the Radius, or Sine of 90°
 To the Departure $b c$ on the Numbers,
 So is the Tangent Complement of the Course,
 Angle c ,
 To the different Latitude $a b$ upon the Numbers.

OPERATION.

Set the Hair B to the Radius, or Tangent of 45 , and the Hair A to the Tangent Complement of the Course $56^{\circ} 15'$, then carefully move this Opening, that the Hair A may cut 52 in the Numbers, the given Departure; and then doth the Hair B cut something more than 78 in the Numbers for the Distance run, $a c$.

ANALOGY.

As the Radius, Sine of 90 ,
 To the Departure bc , 52 Miles,
 So is the secant Complement of the Course
 Angle c $56^{\circ} 15'$;
 To the Distance run a c in the Numbers.

OPERATION.

Set the Hair B to the Sine of 90 , and the Hair A to the Secant of $56^{\circ} \frac{1}{4}$ (which is no other than the Sine Complement) move this Opening that the Hair A may cut the Departure 52 in the Number, and then the Hair B will fall near 94 in the Numbers, the Distance sought; and after this Manner any Question in Plain Traverse, or Mercator Sailing may be wrought with Truth and Expedition.

3. *The Use of the Numbers, Sines and Tangents in the Doctrine of the Sphere, or Practical Astronomy.*

Example, June 25, I would know the Sun's right Ascension, having his Place and greatest Declination given.

ANALOGY.

As the Radius, Sine of 90
 To the Sine Complement of the Sun's greatest Declination, or Obliquity of the Ecliptick,

So

[37]

So is the Tangent of the Sun's Distance from the next Equinoctial Point γ or α in the Ecliptick,

To the Tangent of the Sun's Distance from the same Point in the Equinoctial.

On the Day above given, the Sun's Place is $\odot$ $14^{\circ} 10'$ at Noon, that is $75^{\circ} 50'$ from the next Equinoctial Point α .

OPERATION.

Set the Hair B to the Sine of 90 , and the Hair A to the Sine of the Complement of the Sun's greatest Declination $66^{\circ} \frac{1}{2}$, screw this Opening fast and carry the Hair A to cut $75^{\circ} 50'$, the Sun's Distance from the next Equinoctial Point α in the Tangents, then doth the Hair B cut the Tangent of $74^{\circ} 37'$ the Sun's Distance from α reckoned in the Equinoctial, which subtracted from 180° rests $105^{\circ} 23'$, the Sun's right Ascension reckoned from the beginning of γ , which I turn into Time (by the Table in pag. 93) thus,

		H.	'	"
Deg. 105	is	7	0	0
Min. 15	is	0	1	0
Min. 8	is	0	0	32

Sum 7 1 32 is the Sun's right Ascension in Time.

D 3

2. To

2. *To find the Sun's right Ascension by having the Sun's present and greatest Declination given.*

ANALOGY.

As the Radius, Sine of 90
To the Tangent Complement of the greatest Declination $23^{\circ}\frac{1}{2}$,
So is the Tangent of the present Declination,
To Sine of the Right Ascension.

Example, Let the Sun's Declination be 22° ,
45 N.

OPERATION..

Set the Hair B to the Sine of 90, and the Hair A to the Tangent of $66\frac{1}{2}$; move this Opening of the Sector till the Hair A cut the Tangent of the Sun's Declination $22^{\circ} 45'$, and then doth the Hair B cut the Sine of $74^{\circ} 37'$ the Sun's Distance in the Equinoctial from *Libra* as before.

3. *To find the Ascensional Difference, also the Sun's Rising and Setting, and the Length of the Day and Night in any Latitude.*

ANALOGY.

As the Radius, Sine of 90
To the Tangent of the Latitude,

So

So is the Tangent of the Sun's Declination on the Day proposed,

To the Sine of the Ascensional Difference in Degrees and Minutes, which must be reduced into Time by the Table, p. and if the Declination be North, add the Ascensional Difference in Time to 6 Hours gives the Sun's setting at that Time and Place, which doubled is the Length of the Day, whose Complement to 24 Hours is the Length of the Night, and the Sun's setting subtracted from 12 Hours leaves his rising: But if the Sun's Declination be South, then the Ascensional Difference in Time subtracted from 6 Hours leaves the setting, whose Complement to 12 Hours is the rising, and then the Length of the Day and Night is shewed as above.

Example, August 29th 1725, I would know the Ascensional Difference, the Time of the Sun's rising and setting, the Length of the Day and Night for London and Rome.

OPERATION for *London.*

Note, The Sun's Place and Declination taken at Noon, will be near enough for a Work of this Nature.

Set the Hair B to the Sine 90, and the Hair A to the Tangent of the Latitude $51^{\circ} 32'$; move this Opening till the Hair A cut the Sun's Declination that day at Noon $5^{\circ} 16'$, and then doth the Hair B cut the Sine of $6^{\circ} 40'$, and such is the Ascensional Difference sought, which reduced into Time is $26' 40''$. Now because the Sun has

D 4

North

[40]

North Declination, I add this to 6 Hours, so the

	H.	'	"
Sun sets that Night at	6	26	40
And riseth at	5	33	20

6	26	40	} doubled is {	12	53	20	Day.
5	33	20		11	6	40	Night.

OPERATION for *Rome*.

Set the Hair B to the Sine 90, and the Hair A to the Tangent of the Latitude of *Rome* $41^{\circ} 50'$; move this Opening till the Hair B cut the Tangent of the Sun's Declination $5^{\circ} 16'$, and then doth the Hair A cut the Sine of $4^{\circ} 44'$ the Ascensional Difference sought.

CAUTION.

In all Analogies wrought by this Instrument, you must carefully mind whether your second Tangent be more or less than 45° ; if it be more, as in the Case above, where the Latitude of *London* is $51^{\circ} \frac{1}{2}$, then doth that Hair that lay at Radius, give you the fourth Term or Answer: But if the second Term, viz. Tangent, be less than 45° , as in the Case above for *Rome*, where it was $41^{\circ} 50'$, then the same Hair that lay at Radius, must lie at the third Term, and the Hair that cut the second Term will give the fourth Term. The Reason of this is, because the Tangent of 45° is equal to the Sine of 90° , and that then the Tangents above 45 encrease exceedingly.

Now

[41]

Now this $4^{\circ} 44'$ turn'd into Time is $18' 56''$, which added to 6H. makes 6 H. $18' 56''$, the Time of the Sun's setting at *Rome* on the given Day above.

				H.	'	"
6	18	56	Sun sets, doubled is	12	37	52
5	41	4	Rises, doubled is	11	22	8

for the Length of the Day and Night at *Rome*.

4. *The Latitude of the Place of Habitation, with the Sun's Azimuth given, to find his Altitude upon that Azimuth.*

ANALOGY.

As the Radius, Sine of 90
 To the Tangent of the Latitude,
 So the Sine of the Sun's Azimuth from the
 East or West,
 To the Tangent of his Altitude.

Example, Let the Latitude of the Place be *London*, and the Sun's Azimuth from the East or West $9^{\circ} 40'$, What's the Altitude?

OPERATION.

Set the Hair B to the Sine of 90 , and the Hair A to the Tangent $51^{\circ} 32'$, then move this Opening until the Hair A cut the Sine of $9^{\circ} 49'$, (mind the Caution in pag. 40) and then doth the Hair B cut $12^{\circ} 8'$ in the Tangents, and so high is the Sun at that Time and Place.

5. *Given*

5. *Given the Elevation of the Pole, the Sun's Declination and Hour, or Sun's Distance from the Meridian, to find the Sun's Altitude.*

ANALOGY.

As the Radius, Sine of 90
To the Tangent Complement of the Latitude.
So Sine Complement of the Sun's Distance from Noon,
To the Tangent of a fourth Arch.

Now Note,

If the Time given be between 6 in the Morning, and 6 at Night, then this fourth Arch must be subtracted from the Sun's Distance from the North Pole.

But if the Time be before 6 in the Morning, or after 6 at Night, then add this fourth Arch to the Sun's Distance from the North Pole, the Sum or Difference is the fifth Arch.

Now say,

As the Sine Complement of the fourth Arch,
To the Sine of the Latitude of your Habitation.
So is the Sine Complement of the fifth Arch.
To the Sine of the Sun's Altitude.

Example. What's the Sun's Altitude the 22d Day of April at London at 9 in the Morning, or 3 in the Afternoon?

OPERATION.

Set the Hair B to the Sine of 90° , and the Hair A to the Tangent Complement of the Latitude of *London*, $38^\circ 28'$; move this Opening, that the Hair B may lie on the Sine of the Sun's Distance, from 6 o'Clock, which in this Example is 45° , and then doth the Hair A cut the Tangent of $29^\circ 20'$, which is the fourth Arch.

From a Quadrant	90°	0'
Take the Sun's Declination	15	32
Rest the Sun's Distance from the	}	74 28
North Pole.		
The fourth Arch substracted	29	20
Remains the fifth Arch	45	8

Then set the Hair B to the Sine Complement of the fourth Arch, *viz.* $60^\circ 40'$, and the Hair A to the Sine of the Latitude of *London* $51^\circ 32'$; move this Opening until the Hair cut the Sine Complement of the fifth Arch $44^\circ 52'$, and then doth the Hair A cut the Sine $39^\circ 19'$, the Altitude sought: And thus may the Sun's Altitude at any Time and Place be exactly and speedily found.

6. *Given the Latitude of the Place, the Sun's Declination and Altitude, to find the Hour of the Day.*

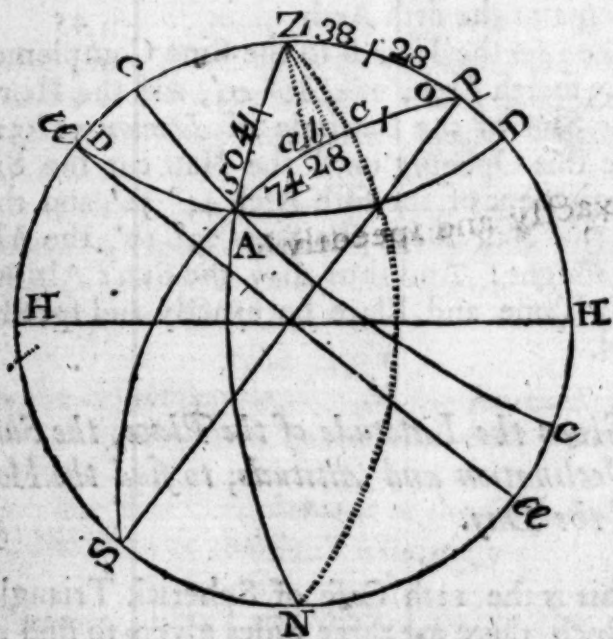
This is the 11th Case of Spherick Triangles, in which there are three Sides given to find the Angle at the Pole.

Example.

Example. April 22d, at London the Sun's Declination $15^{\circ} 32'$, Altitude $39^{\circ} 19'$, what's the Hour?

This will be performed with more Difficulty than the foregoing Problems were to those unskill'd in Spherick *Trigonometry*, for whose sakes is inserted the annexed Scheme for Demonstration Sake.

The primitive Circle represents the Meridian of the Place, P the North Pole, S the South, *ae* the Equinoctial, HH the Horizon, HD the Sun's Altitude 39 19, HP the Latitude 51 32, *ec* the Declination 15 32, in the oblique Spheric Triangle, AZP.



ZP

$\left. \begin{array}{l} ZP \\ AP \\ AZ \end{array} \right\}$ is the Complement of the $\left\{ \begin{array}{l} \text{Lat. } 38^{\circ} 28' \\ \text{Decl. } 74 \quad 28 \\ \text{Alt. } 50 \quad 41 \end{array} \right\}$ Given,

to find the Angle APZ, or Time from Noon.

Rule, Take half the longest Side, viz. AP $74^{\circ} 28'$, half is $37^{\circ} 14'$.

2. Take half the Sum of the other two Sides, viz. AZ $50^{\circ} 41'$ added to ZP $38^{\circ} 28'$, their Sum is $89^{\circ} 9'$, half is $44^{\circ} 34'$.

3. Take half the Difference of the two shortest Sides, viz. AZ and ZP, their Difference is $12^{\circ} 13'$, half is $6^{\circ} 6\frac{1}{2}'$. Now say,

As the Tangent of half the longest Side

To the Tangent of half the Sum of the other two Sides,

So is the Tangent of the Difference of the two shortest Sides,

To the Tangent of half the Difference of the Segment of the Base, which in this Case before us subtracted from half the Base bP leaves cP .

Then in the right Angle spherical Triangle acP , right angled at c , I say,

As the Radius Sine 90 ,

To Tangent cP , above found,

So Tangent Complement ZP,

To the Sine Complement of the Angle cPZ .

OPERATION.

Set the Hair A to the Tangent $37^{\circ} 14'$, and the Hair B to the Tangent $44^{\circ} 34'$; move this Opening until the Hair A cut the Tangent $6^{\circ} 6\frac{1}{2}'$, then will the Hair B cut the Tangent

$7^{\circ} 54'$; Subtract this $7^{\circ} 54'$ from bP $37^{\circ} 14'$, and the Remainder is $29^{\circ} 20'$ cP .

Now, set the Hair B to the Sine of 90 , and the Hair A to the Tangent Complement of the Side ZP, viz. to the Tangent of $51^{\circ} 32'$; then carefully move this Opening of the Sector, until the Hair A cut the Tangent of $29^{\circ} 20'$ (equal to the Side cP) and then doth the Hair B cut the Sine Complement of 45° nearly, and so much is the Angle at the Pole required, which reduc'd into Time, is three Hours; so the Time of the Day is either nine in the Morning, or three in the Afternoon. And by what goes before, it is evident, that any Problem in the Sphere may speedily and exactly be wrought by the Instrument, so I think it needless to give any more Examples of that kind; only to make good my Promise, I shall shew their Use in Dialling.

7. The Use of the Sines and Tangents in Dialling.

First, For an horizontal Dial.

ANALOGY.

As Radius Sine 90 ,

Is to the Sine of the Latitude of your Habitation,

So are the Tangents of 15° , 30° , 45° , 60° , and 75° , severally in the Equator,

To the Tangents of the Distances of the Hour Lines of 1, 11; 2, 10; 3, 9; 4, 8; 5 and

and 7 from the Substile or Meridian upon the Plane.

Example, I would have the Hours Distances of an horizontal Dial for the Latitude of *London*.

OPERATION.

Set the Hair B to the Sine of 90, and the Hair A to the Sine of the Latitude of *London* $51^{\circ} 32'$; screw this Opening of the Legs fast, and move the Hair B to cut the Tangent of 15, then doth the Hair A cut the Tangent of $11^{\circ} 51'$; and such is the Distance of the hour Lines of 1 and 11 from the Substile, and after the same manner you will find the other hour Lines, quarters and half hour Lines, as exhibited in the adjacent Table. But when the Tangent in the Equator, which in the Proportion is your third Term, exceeds 45, then doth the Hair B that lay at Radius give the fourth Term; mind the Caution in Page 40.

The first Column is the Hours, half hours and quarters; in the Second is con-

H.	0	0	0	0
12	0	0	0	0
$\frac{1}{4}$	3	45	2	56
$\frac{1}{2}$	7	30	5	52
$\frac{3}{4}$	11	15	8	51
11	15	0	11	51
$\frac{1}{4}$	18	45	14	52
$\frac{1}{2}$	22	30	17	57
$\frac{3}{4}$	26	15	21	6
10	30	0	24	20
$\frac{1}{4}$	33	45	27	36
$\frac{1}{2}$	37	30	31	0
$\frac{3}{4}$	41	15	34	28
9	45	0	38	3
$\frac{1}{4}$	48	45	41	45
$\frac{1}{2}$	52	30	45	34
$\frac{3}{4}$	56	15	49	30
8	60	0	53	35
$\frac{1}{4}$	63	45	57	47
$\frac{1}{2}$	67	30	62	6
$\frac{3}{4}$	71	15	66	33
7	75	0	71	6
$\frac{1}{4}$	78	45	75	45
$\frac{1}{2}$	82	30	80	25
$\frac{3}{4}$	86	15	85	13
6	90	0	90	0

tain'd

tain'd the Degrees and Minutes in the Equinoctial answering to those Hours, being the same with the Angle at the Pole; the third and last to the right Hand contains the Degrees and Minutes of each Hour Distance upon the Plane.

Lastly, For the Hour Distances upon a vertical North and South Plane.

ANALOGY.

As Radius, Sine 90

To the Sine Complement of the Latitude of
your Habitation,

So are the Tangents of 15, 30, 45, 60 and 75°,
being the Angle at the Pole of each several
Hour Line.

To the Tangents of the Distances of the Hour
Lines of 1, 11; 2, 10; 3, 9; 4, 8; 5, 7; as
this Table sheweth.

OPERA-

O P E R A T I O N.

Set the Hair B, to the Sine of 90, and the Hair A to the Sine of $38^{\circ} 28'$ (it being the Complement of the given Latitude $51^{\circ} 32'$) ; to this opening screw the two Legs of the Sector fast, and move the Hair B to cut 15° in the Tangents, and then doth the Hair A cut the Tangent of $9^{\circ} 28'$, which is the Distance of the hour Lines of 1 and 11 from the Substile or twelve o'Clock ; and thus by the Instrument you may examine this Table, or make another for any given Place. I suppose my Reader to be acquainted with Dialling, so I shall forbear to shew how to delineate the hour Lines when calculated, or the making of any other Dial, because that is not my present Design, but to shew only the Use of the Instrument.

Hours	Ang. at the Pole	Hour Distan
12	0 0	0 0
1	3 45	2 20
2	7 30	4 41
3	11 15	7 3
4	15 0	9 28
5	18 45	11 56
6	22 30	14 27
7	26 15	17 4
8	30 0	19 45
9	33 45	22 35
10	37 30	25 32
11	41 15	28 38
12	45 0	31 54
1	48 45	35 22
2	52 30	39 3
3	56 15	42 58
4	60 0	47 9
5	63 45	51 36
6	67 30	56 20
7	71 15	61 23
8	75 0	66 42
9	78 45	72 17
10	82 30	78 3
11	86 15	84 0
12	90 0	90 0

4. *The Description and Use of the Space between the third and fourth Circles.*

This great Space is divided into 12 equal Parts, in which are engraved the Figures of the Zodiacal Constellations, as the Ram, the Bull, the two naked Boys, the Crab-fish, the Lyon, the Virgin, the Ballance or Pair of Scales, the Scorpion, the Archer or shooting Horseman, the Goat, the Water-bearer, and the two Fishes.

In this same Place, you have also all the Eclipses of the Sun and Moon, that will be visible at *London*, until the Year 1730, as for Example, looking upon the Instrument, I see 1724 $\odot$ 6^h 36' D 11 $\frac{1}{2}$, upon which lay one of the Hairs of the Sector, and it will cut the 11th Day of *May*, which is to inform you that the Sun is then eclips'd, and the greatest Darkness thereof will be at 36 Minutes past six at Night, when 11 $\frac{1}{2}$ Digits will be eclipsed on the under side, as the D for Digits signifies; *Note*, That with Rays about it, thus $\odot$, is the Sun, and that without Rays, thus $\bullet$, is the Moon; and when the Luminary is but Part eclipsed, there it is also shewed thus $\frown$; when the lower Side is eclipsed, or thus $\smile$, when the upper Side is obscured; whenever you find the Figures, which represent the apparent Time of the middle Eclipse to be more than 12, that the Excess above 12 is the Time the next Morning, as 17 Hours is at 5 the next, &c. for all astronomical Times begin at Noon on one Day, and ends at Noon the next

next; see the Word *Time*. *Example 2*, On *Sept. 8th 15th 2^o*, *Anno 1736*, you will find  15 2 D 204, which tells you that the Moon is totally eclipsed at 2^o past three in the Morning on the ninth of *September 1736*.

Also here you have the Conjunction of Saturn, Jupiter and Mars,  6 h 4 3, in 24^o 7, to which lay the Hair of the Sector, and it cuts *December 29 1722*, the Time when that Conjunction happened.

In the same Space you will also find when the two inferior Planets, Venus and Mercury, may be seen in the Sun. As for Instance, In one of the Twins, you will find 1751  in  at 10 M, which is to inform you that at ten o'Clock in the Morning, or Forenoon, the Planet Venus may be seen in the Sun, to which lay your Hair, and it cuts *May 26*.

And *Anno 1769*  in  at 9 N, to which lay the Hair, and it cuts *October 29*. And *Anno 1775*  in  at N, to which lay the Hair, and it gives you *October 22*, the Day when that happens: Note, Whenever you find a Figure with an N annexed, tells you that is at Night, at so many Hours as the Figure expresses; but when you meet with an N, and no Figure annexed, as in the Years 1736, and 1743, then that Time is at Noon. Farther note, That when two several Eclipses, conjunction Transits, &c. happened upon one and the same Day, that then you will find them plac'd in the Space between Circle 12th and 13th, amongst the Saints Days; as for Instance, in the Years 1736 and 1743, on *October 31*, and *October 25*, you will find two Transits of  over the Sun's Disk, placed here

for the Reason above given: And likewise an Eclipse of the Moon on the 14th Day of *February Anno 1747*. These Eclipses and Transits are not only pleasant for Gentlemen to contemplate, but also useful to Mankind in general, as being helpful in determining the Difference of Meridians between any two Places upon this terraqueous Ball.

5. *Description and Use of the Fifth Circle.*

Note, The 4th Circle is nothing but an Aboundary of the 5th.

The 5th Circle, as mark'd on the Legs of the Sector, contains the Signs of the Zodiack, which are 12 in Number, noted by their proper Characters, each Sign being divided into 30 equal Parts call'd Degrees, and Numbers with 10, 20, 30, each; in this you have the Sun's Place answering to each Day in the Year, as I shall shew when I come to speak of the Days, &c.

6. *Description and Use of the Sixth Circle.*

In this Circle you have the Sun's right Ascension in Time, beginning with one Hour, and numbred round with 2, 3, 4, &c. to 24 Hours; this Circle is unequally divided, to answer the Sun's Place each Day in the Year, every Division of which is one Minute in Time; its Use is to find the Time of Southing of the Planets and fixed Stars; for if from the right Ascension of the Moon or Star, you take the Sun's right Ascension

fion in Time, there will remain the Hour and Minute of their Southing : By laying the Hair of the Sector to the Day of the Month in the 12th Circle, or to the Sun's Place in the 5th Circle, it will give you the Sun's right Ascension at that Time : And so for the Moon or any Star that are in or near the Ecliptick, by laying the Hair to their Longitude, it gives you their right Ascension in Time: But if the Moon or Star have Latitude (as frequently they have) it increaseth, or diminishes the right Ascension according to the Star's Place at that Time, for if it have North Latitude and be

In { $\varpi \approx \times \vee \gamma \Pi$ Decreases } right Ascension.
 { $\odot \Omega \Upsilon \triangle \cap \ddagger$ Increases }

But if the Star have South Latitude

In { $\varpi \approx \times \vee \gamma \Pi$ Increases } right Ascension.
 { $\odot \Omega \Upsilon \triangle \cap \ddagger$ Decreases }

I shall here subjoin a new Table, shewing in each Sign, to 9° of North and South Latitude, how much you shall add or subtract to or from the right Ascension in the Ecliptick found by the Instrument, that so you may gain the true right Ascension of the Star answering unto its Latitude and Longitude.

[illegible]

The Use of this TABLE.

With the Longitude of the Planet or Star, enter the 5th Circle of the Instrument, to which lay the Hair of the Sector, and then it will cut the 6th Circle, and give you its right Ascension: Supposing it to be the Ecliptick; thus done, enter this Table with the Star's Latitude on the Head, and Longitude in the first or second Column, and in the Angle, or Place of Meeting, you have the Minutes and Seconds in Time to be added to, or subtracted from, the right Ascension, as the Table directs above found, and the Sum or Remainder will be the true right Ascension of that Star. *Example, Anno 1725, December 3,* I would know at what Time the Moon will be upon the Meridian in the South: The Moon is 10 Days old, and consequently the estimate Time of Southing is at eight at Night, at which Time I find her Place in Longitude to be γ $16^{\circ} 58'$, in Latitude $0^{\circ} 56'$ South; now, I turn to the Instrument and move one of the Hairs of the Sector to the Longitude of the Moon, γ $16^{\circ} 58'$, and it cuts the right Ascension in one Hour two Minutes; this done, with the Moon's Latitude $56'$ South, I turn to the annexed Table, and enter γ South Latitude, with one Degree (and by making Proportion for the 16 Degrees of Longitude) I find $1^{\circ} 30''$ with the Title Add, therefore to the right Ascension above found, as in the Ecliptick $1^{\text{h}} 3^{\text{m}} 30''$, the Moon's true right Ascension; then to the Time propos'd, the Sun's Place is π $22^{\circ} 54'$, to which bring one of the Hairs in the Instrument, and it cuts $17^{\text{h}} 28^{\text{m}} \frac{1}{3}$ for the Sun's right Ascension, which

E 4

subtracted

subtracted from the Moon's right Ascension) by first adding 24 Hours, which you must always do when need requires) there remains $7^h 35' 10''$, the true Time of Night that the Moon will be upon the south Part of the Meridian.

7. *The Description and Use of the Seventh Circle.*

This Circle gives the Sun's Declination every Day in the Year, and is divided and laid down according to the Sun's Place, or Days of the Month, into four grand unequal Divisions, beginning Υ and ϖ and numbred each Way to $\odot$ and ϖ with $10^\circ, 20^\circ, 23^\circ 30'$, being the Sun's greatest Declination when he enters the tropical Signs $\odot$ and ϖ . Every Division of this Circle, from 0° to 23° is $15'$, but from 23° to $23^\circ 30'$ (here the Declination alters but slowly) each Division is $5'$ till you come to $23^\circ, 25'$, and then you have four Dots, every one of which is a Minute, which brings you to $23^\circ 30'$ the greatest Declination.

The Sun's Declination increaseth from the 9th of *March* to the 10th of *June*, and from the 12th of *September* to the 10th of *December*; in the former Case it is North, and in the latter, South.

It decreaseth from the 10th of *June* to the 12th of *September*, and from the 10th of *December* to the 9th of *March*; in the first Case it is North, and South in the latter; so that from *March 9*, to *September 12*, the Sun has North Declination; that is, while he is running thro

thro' these fix Signs γ , δ , Π , $\S$, Ω , M : And from *September* 12, to *March* 9, he has south Declination; that is, while he is running thro' these fix Signs m , m , z , w , ss , x , as the Instrument plainly sheweth.

Example, What's the Sun's Declination the third of *July*?

OPERATION.

Lay the Hair to the Day of the Month in the 12th Circle, or to the Sun's Place $\S$ 21 48 in the 5th Circle, and it will cut the Circle of Declination in $21^{\circ} 44'$, and is North as the Title directs. I might here subjoin Tables (as I have done for the right Ascension) to make the Instrument serviceable in the Planets and Stars Declinations, but that would cause the Book to swell too much; besides I should then exceed the Bounds of my intended Design.

8. *The Description and Use of the Eighth Circle, as mark'd on the Sector.*

This Circle gives you the Sun's Amplitude, serving only for the Latitude of $51^{\circ} 32'$; beginning at γ and m , and numbred each Way with 10, 20, 30, $39^{\circ} 52'$, ending at $\S$ and w , being the greatest Amplitude that can happen in the Latitude abovemention'd, *See Page* : Every Division of which is $30'$ till you come to 39° , and then each Division is $10'$, which bring you to $39^{\circ} 52'$, the greatest Amplitude; it increases and decreases as the Declination doth, which see, and

and is always North, when the Sun is in northern Signs; and South, when he is in southern.

Example, What's the Sun's Amplitude, July 3?

OPERATION.

I lay the Hair of the Sector to either the Day of the Month in the 12th Circle, or to the Sun's Place in the 5th Circle, and it will cut the eighth Circle in $36^{\circ} \frac{2}{3}$, the Amplitude of rising and setting from the East and West to the Northward. It is of great Use to Mariners to find the Variation of the Compass.

9. *The Description and Use of the Ninth Circle, as mark'd on the Sector.*

This Circle shews the Sun's rising and setting every Day in the Year, for the Latitude of $51^{\circ} 32''$; in which the Roman Letters stand for his rising; and the common Figure the setting; every Division of which Circle is a Minute in Time, in which you may observe the Sun rises on the 10th of *June* (being the longest Day) at $3^h 47' 16''$, and sets that Night at $8^h 12' 44''$ which are the Complement of each other to 12 Hours; the Double of the Sun's setting, always gives the Length of the Day; so the longest Day in Latitude of *London* is $16^h 25' 28''$, which taken from 24 Hours leaves the Length of the Night, $7^h 34' 32''$, See Page 17, the Words *Rising* and *Setting*. When you would find the Sun's rising and setting for any Day proposed,

lay

lay one of the Hairs of the Sector to the Day of the Month, and it cuts this 9th Circle in the Hour and Minute of the Sun's rising that Day.

Example, July 4. I would know the Time of the Sun's rising and setting, the Length of the Day and Night, and how much the Days have decreas'd.

OPERATION.

Lay the Hair of the Sector to the given Day, *July 4*, and it cuts this 9th Circle at 40" past 4, the Sun's rising; and 40" before 8, his setting; which doubled, is 15^h 58' 40", the Length of the Day; this subtracted from the longest Day at *London* 16^h 25' 28", rests 26' 48", and so much are the Days shortned.

10. *The Description and Use of the Tenth Circle, as mark'd on the Sector.*

This Circle gives you the Equation of natural Days, commonly called the Equation of Time, the Reason of which you have under that Word, to which I refer you; it is numbred round with Figures, which signifies Minutes, and the Divisions are Seconds, every one of which is 15". There are four Days in the Year that the Sun and pendulum Clock go together, which are these,

April 4

June 6

August 20

December 12

with these Words, fast, slow, which tells you whether the Watch is faster or slower than the Sun.

There

There are also four Days in the Year on which the greatest Equations happen, viz.

			" "	Watch too
<i>January</i>	30	Equations	4	59 fast.
<i>May</i>	4		4	13 slow.
<i>July</i>	15		5	46 fast.
<i>October</i>	23		16	9 slow.

When you would find the Equation of any Day, you have no more to do than to lay the Hair of the Sector to the Day of the Month, and there is the Equation given.

Example, July 5, I would know the Equation, and whether the Sun, which shews the apparent Time, or the Watch, which shews the equal Time, is then the fastest.

OPERATION.

Lay the Hair of the Sector to the given Day, *July 5*, and it cuts this 10th Circle in $5^{\circ} 14''$, Watches too fast.

Note, On each Side of the four Days of the greatest Equation, you will meet with half Divisions, which are $5''$ each, as against *July 9* and *11*, short of the Day of the greatest Equation, and on *July 19* and *21*; on the other Side the greatest Equation you will meet with four such half Divisions.

11. *The Description and Use of the Eleventh Circle, as marked on the Sector.*

This Circle contains the Letters proper for each Day in the Year, being the first Seven of the Alphabet, and serveth to find the Day of the Week, having first found the Sunday Letter, which is always one of those Seven, in a common Year; but the Leap-Year hath two, the first serving from the first of *January* to the 24th of *February*, and the other Letter from thence to the Year's End.

The Letter that begins each Month in the Year is known by the first Letter of the following Words, *viz.*

At, Dover, Dwells, George, Brown, Esquire,
Jan. Feb. March, April, May, June,
 Great, Charles, Finch, And, David, Frier,
July, August, Sept. Octob. Nov. Dec.

By which you may observe, that *January* and *October* begins with an A; *February, March,* and *November* with D; *April* and *July* with G; *May* with B; *June* with E; *August* with C; and *September* and *December* with the Letter F. By these several Letters are the Days of the Week known, for having first found your Sunday Letter for the given Year, the next Letter in Order is Monday, the next Tuesday, &c.

Example, I would know what Day of the Week the 6th of *July*, in the Year 1725.

The

The Dominical or Sunday Letter is C, which I look for in the given Month *July*, and I find it plac'd with the 4, 11, 18 and the 25 Days, which are all Sundays in *April* and *July*, therefore if the 4th be Sunday, then the 5th is Monday, and the 6th is Tuesday, &c.

Example 2, What Day of the Week doth *Christmas-day* fall on, in this Year 1725? Having found the Sunday Letter C, for the given Year 1725; I find it plac'd against the 5, 12, 19 and 26 Days in *September* and *December* (according to the Verse in Page 61) which Days are all Sundays. then the 25th is Saturday.

12. *The Description and Use of the Twelfth Circle, as mark'd on the Sector.*

This Circle contains the Months with the Days in each; the Number of Days in each Month are express'd by the Roman Character, and each particular Day by a Graduation, and numbred with 10, 20, 30, or 31; and in *February* the Days are numbred with 10, 20, 28, which are the Number of Days that Month contains in a common Year, but in the Leap-Year, it has 29 Days; but, however, the Days in every Month answering the Sun's Place in general thro' a Revolution of four Years, therefore the Leap-Year and the three common Years are reduc'd to an Equality, in which the Leap-Day is distributed amongst them all four. For in every of the three common Years the Sun's Place is on the same Day of the Month in the following Year less by 44' 20'', but in the Leap-Year it is increas'd by 44' 48'', that is the Motion of a Day, 59' 8'', less'n'd by

by $14' 20''$, as is evident from the following Table deduced from Calculation.

January 1,	1721		$22^{\circ} 20'$	} At Noon.
	22		$22 \quad 5$	
	23		$21 \quad 51$	
	24		$21 \quad 56$	
	25		$22 \quad 22$	

June 1,	1721		$21 \quad 16$	} At Noon
	22		$21 \quad 2$	
	23		$20 \quad 48$	
	24		$21 \quad 31$	
	25		$21 \quad 17$	

December 1,	1721		$20 \quad 30$	} At Noon.
	22		$20 \quad 15$	
	23		$20 \quad 0$	
	24		$20 \quad 46$	
	25		$20 \quad 31$	

By which it appears, that in finding the Sun's Place by the Instrument, there will be no less than $30'$ Difference on the same Day of the Month in the first past Leap-Year, and on the third past Leap-Year: But the Instrument being (*viz.* the Days of the Month and Sun's Place) adapted to the first after Leap-Year; therefore, if it be 2d past, then subtract $14' 20''$ from the Place by the Instrument, and in the 3d past Leap-Year subtract $28' 40''$, but in the Leap-Year add $44' 48''$, and you will by this Method

Method come at the Sun's true Place, agreeing with Calculation.

Example, what's the Sun's true Place on September 8, at Noon, in the following Years 1725, 26, 27, and 1728?

OPERATION.

Lay the Hair of the Sector to the given Day, and it cuts the 5th Circle in $\mathbb{M}$ about $26^{\circ} \frac{1}{2}$, then because the Year 1725 is first past Leap-Year, I conclude that to be the Sun's true Place for that Day and Year; then from $\mathbb{M}$

	$26^{\circ} 30' 00''$	
Sub.	$14 \frac{1}{2}$	
Rest $\odot$ Place 1726 the same Day	$26 \ 15 \ 40$	
Sub.	$14 \ 20$	
Rest $\odot$ Place 1727 the same Day	$26 \ 00 \ 20$	
Add	$44 \ 48$	
Sum $\odot$ Place 1728 the same Day $\mathbb{M}$	$26 \ 45 \ 8$	

By this Method you will nearly come at the Sun's true Place at any Time.

13. *The Description and Use of the Thirteenth Circle, as marked on the Sector.*

In this Circle are placed the fixed Feasts, Terms and their Returns, answering to the Days of the Month in the 12th and 14th Circles; and there you have also a Transit of Mercury over the Sun, with a Lunar Eclipse, as mention'd in Page

as for Example, lay the Hair of the Sector even with the Bottom of any Word herein mention'd, and it will cut the Days of the Month in the 12th and 14th Circles that such Feast falls upon; as for Instance, *St. James* I find to be *July 25*, and looking in *January*, I find Term begins; the Hair laid to the Bottom of the Word (that is even with the Line that the Word is suppos'd to stand in) and it cuts the 23d Day of the Month, the Day that *Hillary* Term begins; but when that Day is Sunday then the Term begins on Monday, and likewise on Monday in *Michaelmas* Term, &c. ; these are call'd fix'd Terms, because they keep one certain Day of the Month, as you may find them placed in the Instrument: Also in the Calendar Circle you will find the Words *Fire of London*, to the Bottom of which lay the Hair, and it will cut *September 2*, which is the Day on which that great Conflagration begun in the Year 1666. Lastly, I find wrote Octab. Pur. (see the Word *Return*) the Hair laid to it will give *Feb. 9*, for the last Return of *Hillary* Term, which signifies Octabis Purificationis, that is eight Days after the Purification of our blessed Virgin *Mary*; and in this Circle the Days are represented by Dots, and figured with 10, 20, 30 and 31, as the Month has 30 or 31 Days.

14. *The Description and Use of the Fourteenth Circle, as marked on the Sector.*

This Circle contains the Days of the Month, and serves for the same Purpose that the 12th and 13th Circles do.

15. *Description and Use of the Fifteenth Circle.*

This Circle is divided into 52 equal Parts, distinguished by large Dots, every one of which answers to 7 Days in the 14th Circle, and numbered round with 1, 2, 3, &c. to 52, which end at *December 30*: Its Use is to know the Number of Weeks from the Beginning of the Year, to any Day in the Year propos'd. As for Example, I would know how many Weeks it is from *January 1*, to *July 9*. Look for *July 9* in the 11th or 14th Circle, to which lay the Hair of the Sector, and it will cut the 15th Circle at 27 Weeks and one Day; now because the Year contains 52 Weeks and one Day, therefore take away one Day, and you will have just 27 Weeks from *January 1* to *July 9* inclusive, and so of the rest.

16. *The Description and Use of the Sixteenth Circle.*

This Circle contains the Days in the Year, and is number'd round with 10, 20, 30, &c. to 365, being the Number of Days in the Year, where that Reckoning ends at *December 31*, and answers to the Days in the 14th Circle: The Use of it, is to know how many Days it is between any two Number of Days propos'd.

As for Example, Suppose I would know how many Days it is from *January 1*, to *July 8*.

OPERATION.

Look for *July 8* in the 12th Circle, to which lay the Hair of the Sector, and it will cut the 16th Circle at 189, which are the Days proposed.

Example 2. How many Days is it from *April 29* to *August 29*?

Place the Hair A to *April* the 29th, and the Hair B to *August 29*; screw this Opening fast and move the Hair A to 365 upon the 16th Circle, and then doth the Hair B cut 122 upon the same Circle, which are the Number of Days required, and the Weeks upon the 15th Circle, which are 17 Weeks and 3 Days, &c.

By the first Example, above, find how many Days there are from *January 1* to *April 29*, and *August 29*, severally, subtract the one from the other, and the Remainder is the Answer; thus,

From <i>January 1</i> to <i>April 29</i> , are Days	119
From <i>January 1</i> to <i>August 29</i> , are Days	241
Difference, is Answer in Days	122

Note, In Leap-Year, add one Day more to your Account, or Answer! But the Instrument performs any Addition or Subtraction upon this, or upon the Circle of Weeks.

17. *The Description and Use of the Seventeenth Circle.*

This Circle contains these Letters of the Alphabet, a, b, c, d, e, f, g, h, i, k, l, m, n, p, q, r, t, u, w, being 19 in Number, and answers to the 19 Primes and Epacts. These are taken from Table II. and transferred into this Circle, to shew the New and Full Moons : For when the Epact is 1, the Letter a is put to represent it ; the following Year the Epact will be 12, there the Letter b is placed, to represent that Epact ; and the next Year after that the Epact will be 23, which is represented by the Letter c ; and so on all round the 19 Epacts, as you may the better perceive in Table II. Then having found the Epact for any given Year, if you add that to the Number of Months from *March*, and subtract the Sum from 30, the Remains is the Day of the Month that the Moon changes on ; so that from Table II. the Letter that answers to the Epact is placed in this 17th Circle right against the Day of the Month on which the Moon changes that Year.

Now you are not to suppose or imagine that the Letters in Table II. have any more Right or Title to the Epacts with which they are placed than any other would have, but only when the Epact is 1 the first Letter in the Alphabet is adapted to it, &c. and therefore Number and Alphabet begin together.

Example,

Example, I would know the Change, Full and Quarters of the Moon in *July* 1725.

OPERATION.

Have Recourse to Table II, and there looking in the highest Line, I find the Year 1725, and under it 16, the Golden Number, and under that 26 f, the Epact and Letter for the said Year. This done, go to the Circle of Months and find the Letter f (which is the Letter of Direction in this Case) in the 17th Circle, to which lay the Hair of the Sector, and it cuts the 28th Day of *July*, the Day on which the Moon changeth ;

Now observe, from - - - - - 28
Substr. 7

Last Quarter is upon the - - - - - 21 Day.
Substr. 7

Full Moon is upon the - - - - - 14 Day.
Substr. 8

First Quarter is upon the - - - - - 6 Day.

But when the New Moon happens in the first seven Days of the Month, then you must add two sevens and two eights and that will give you the First Quarter, Full Moon, and Last Quarter, and also will bring you to the next New Moon ; for these two seven and two eight Days make 30 Days, which is about half a

Day too much from one Conjunction or New Moon to another.

Now you are to observe, that this Method finds the New and Full Moons according to their mean or middle Motion, supposing them to move in Circles, and equally every Day alike; according to which the Sun moves in a Day $59^{\circ} 8''$ and the Moon $13^{\circ} 10' 35''$, their Difference $12^{\circ} 11' 27''$ is the mean Motion of the Moon from the Sun in a Day; now at this Rate their mean Conjunction is made in 29 D. 12 H. 44' 6'', which is sooner by 11 H. 15' 54'' than is shewed by the Instrument. But Astronomers well knowing that the Luminaries (according to Appearance) do not move in Circles, but in Ellipses, therefore their Motions cannot be equally alike every Day, so that the mean Conjunction above-mentioned is not the true, but will be sometimes too soon, and at other Times too late, but will never differ more than 14 Hours of the true Time.

Example 2. I demand the Change, Full and Quarters of the Moon in *December 1725*.

OPERATION.

The Letter of Direction was found in the last Example to be f, (which always serves all the Year) this I seek in the 17th Circle, under the Month *December*, to which I lay the Hair of the Sector, and it cuts the Circle of Months in *December 23*, which is the Day of the New Moon, in that Month and Year; to which add 8 Days, there is given the 31st Day of *December* for the First Quarter, and subtract 8 there is given

given the 15th Day for the Last Quarter, subtract 7 from 15 leaves 8 for the Full Moon, and 7 from that gives *December 1* for the First Quarter.

To know when to add or subtract 7 or 8 Days, depends purely upon the Knowledge of the Moon's Apogee and Perigee, Things purely Astronomical, therefore you may do it at your own Discretion.

18. *The Description and Use of the Eighteenth Circle.*

This Circle has the Names of the Points of the Compass, which are in Number 34, beginning at North with N, and so numbering round, and putting the first Letter of the Word for the whole Word, as NbE signifies North or Nore by East, as underneath.

N	-	-	North
NbE	-	-	Nore by East
NNE	-	-	Nore Nor East
NEbN	-	-	Nore East by North
NE	-	-	Nore East
NEbE	-	-	Nore East by East
ENE	-	-	East Nor East
EbN	-	-	East by North
E	-	-	East
EbS	-	-	East by South
ESE	-	-	East South East
SEbE	-	-	South East by East
SE	-	-	South East
SEbS	-	-	South East by South

SSE	- - -	South South East
SbE	- - -	South by East
S	- - -	South
SbW	- - -	South by West
SSW	- - -	South South West
SWbS	- - -	South West by South
SW	- - -	South West
SWbW	- - -	South West by West
WSW	- - -	West South West
WbS	- - -	West by South
W	- - -	West
WbN	- - -	West by North
WNW	- - -	West North West
NWbW	- - -	North West by West
NW	- - -	North West
NWbN	- - -	North West by North
NNW	- - -	North North West
NbW	- - -	North by West.

Although there are but 32 Lines near the Center of the Instrument in which the Havens are wrote, yet there are the Names of 34 Havens inserted, because *Brest* and *Scilly*, which are two several Places, are wrote both in one Line; as also are *Leith* and *Maes* both in another Line, which are also two different Places.

Every Point of the Compass is $11^{\circ} 15'$, and every Division thereof is $3^{\circ} 45'$ of a great Circle; but in Time every Point is $45'$, and every Division or Quarter Point contains $11' 15''$.

The Use of this Circle is to know what Point of the Compass the Moon is upon, on the Full and Change Days; for that being turn'd into Time, allowing (as above) $45'$ to every Point, and that Time added to the Time of the Moon's Southing

Southing any Day, will give the Time of High Water the same Day at the given Port, which I shall further explain in the two following Circles, because this Circle, and the two following depend one upon another.

19. *The Description and Use of the Nineteenth Circle.*

This Circle is divided into 24 equal Parts, or Hours, and number'd with one, two, three, &c. to twelve, and then the other Semicircle begins again with one, and is number'd as before with Roman Letters; every Hour is again subdivided into twelve equal Parts, every one of which is 5' in Time; this Circle of Hours answers to the 18th Circle of the Points of the Compass, where you may observe that North East and South West is three Hours in Time; and so likewise all the Points of the Compass in the 18th Circle have the Time answering in the 19th Circle; that is, shews you in Time how much any Point of the Compass is distant from the Meridian, counting round according to the apparent Motion of the Sun, viz. from East to West: Its Use I shall shew when I have explained the 20th Circle.

20. *The Description and Use of the Twentieth Circle.*

This Circle is divided into 30 equal Parts, and number'd round with 1, 2, 3, 4, &c. to 30, being the Days of the Moon's Age, from Change to Change, according to her mean Motion,

tion, as set down in the Description of the 17th Circle. Between this Circle and the Center of the Instrument you have the Names of 32 Ports or Havens, and they are set against that Point of the Compass in the 18th Circle, on which the Moon is, upon the Full and Change Days ; as for Instance, you have *London* right against North East, which tells you that a North East and South West (because there is every twelve Hours a Tide) Moon makes High Water at *London* Bridge on Full and Change Days, which answers to three Hours in Time in the 19th Circle ; also at *Portsmouth* and *Southampton* a North and South Moon makes full Sea on Full and Change Days ; for whenever the Moon is on the Meridian, 'tis full Sea at those Ports, and so of the rest ; which Ports you will find inserted amongst the Cities at the End of this Book.

21. *The Use of the Eighteenth, Nineteenth, and Twentieth Circles, &c.*

First, In the Description of the 11th Circle I have shewed how to find the Day of the Week. And,

Secondly, In the Description of the 17th Circle I have shewed how to find the New and Full Moons in any Month and Year.

Thirdly, To find the Moon's Place in the Zodiac for any Day of her Age.

First, Find the Day of the last Change (as has been shewed in pag. 69, 70.) in the 17th Circle ; bring one Hair of the Sector to that Day,

Day, and where it cuts upon Circle 20, count in that Circle so many Days forward as the Moon is old; where that Reckoning ends, lay the Hair of the other Leg of the Sector, and it will cut the Circle of Signs (*viz.* the 5th Circle) in the Sign and Degree of the Moon's Place in Longitude, with respect to the last Conjunction; but, because the Sun moves near a Degree in a Day the Year round, therefore to the Sign and Degree of the Zodiack above found, add so many Degrees as the Moon is Days old, and you will have her Place pretty near the Truth; nay near enough in a Work of this Nature: And that Place so found, will be to the same Time of the Day that the last Conjunction was at; *i. e.* if the last Conjunction of the Sun and Moon was at eight in the Morning, then the Moon's Place in Longitude found by this Instrument is also at eight o' Clock in the Morning on that Day proposed.

Example, I would know the Moon's Place in Longitude on the 10th Day of *July* 1725.

By the Method in pag. 69, I find the last New Moon was upon *June* 28, to which I lay one of the Hairs of the Sector in the 12th Circle, and it cuts the 20th Circle at a little more than 24; here begin and count forward in this Circle as many Days as the Moon is old, which in this Example are 12, so I call 25 one, 26 two, and so on; so that the Moon's Age 12 ends at a little more than 6 in the 20th Circle, to this I bring the other Hair of the Sector, and it then cuts the 5th Circle of Signs at $\text{♋ } 11^{\circ}$, to this
add

add 12° (for the Reason above) the Sum is 72° , the Moon's Place in Longitude, which is at Midnight on the said 10th Day, because the last New Moon was at that Time, which is surprizingly near the Truth.

Example 2. Let the Moon's Place be sought on September 18, 1725.

First, I find the last New Moon was Aug. 26, and the Moon is now 23 Days old; the Hair brought to the Day of the Month given, cuts the 20th Circle in 29; at this 29 I begin and count the Moon's Age 23, which ends at 22 in this 20th Circle, to which I bring the other Hair of the Sector and it then cuts the 5th Circle of Signs in $\Pi 23^{\circ}$, to which I add 23° (the Number of Days the Moon is old) and the Sum is $\S 16^{\circ}$, the Moon's Place in Longitude on the given Day at 6 at Night, because the last New Moon was at that Time.

4. To find the Time of the Moon's Southing.

In the Description of the 6th Circle pag. 52, I have given the exact Method of finding the true Time of the Moon's Southing; but because every one is not an Astronomer, that Method may seem too prolix, I shall here shew you how to do it speedily by the Instrument, but withal you must remember, that this Method will often fail you some Minutes in the true Time, because it supposes the Moon to move always equally alike in the Ecliptick.

Rule,

Rule. Find the Moon's Age in the 20th Circle, and against that in the 19th Circle, is the Time of her Southing that Day.

Example. July 11, 1725, I would know what Time the Moon will be South.

Counting from the Day of the last Change to the Day proposed is 13 Days her Age, which sought in the 20th Circle, gives 10 H. 24' in the 19th Circle, the Time of her Southing. You must observe that if her Age exceeds 15 Days, that then the Time found as above is in the Morning.

Example, July 21, 1725, I would know the Time of the Moon's Southing.

The Days of her Age 23, in the 20th Circle gives 6 H. 24' in the Morning, because her Age is more than 15 Days.

5. *To find the Time of High Water at any of the Ports mentioned in the Instrument.*

Rule. Bring the Hair A to 30 in the 20th Circle, and the Hair B to the Day of her Age in the same Circle, screw this Opening fast, and with this Opening lay the Hair A to the Port where you would find the Time of High-Water, and then will the Hair B cut the 19th Circle at the Time of High Water at that Port.

Example

Example. July 12, 1725, I would know the Time of High Water at *London Bridge*.

OPERATION.

The Hair A laid to 30 in the 20th Circle, and the Hair B to the Moon's Age, 14 Days, this Opening screw'd fast, I move the Hair A to the given Port, *viz. London*, and then the Hair B cuts 2 H. 12', the Time of High Water.

Also if I move the said Opening that the Hair A may cut the Port *Onkney*, then will the Hair B cut the 19th Circle at 8 H. 12', the Time of High Water at that Port on the same Day, &c.

Note, Every Tide comes later by 24', because there is a Tide every 12 Hours and 24', according to the mean Motion of the Moon of 48 a Day.

6. To find the Time of the Moon's Rising and Setting.

Rule, Bring the Hair A of the Sector to the Day of the Moon's last Change in the 11th or 14th Circles, here hold it fast, and observe where it cuts the 20th Circle, here begin and count so many Days as the Moon is old, to which lay the Hair of the Leg B in the 20th Circle, and in Circle 9 it will cut the Hour and Minute of the Sun's setting (which is always equal to the Semidiurnal Arch or Half Stay above the Horizon (see the Description of the 9th Circle) where he is in that Place of the Zodiac;

diack; now because the Moon comes later to the Horizon every Day by 48', therefore to the Sun's setting, found as above, always add 12'; and that Sum is the Semidiurnal Arch of the Moon, or her Half Stay above the Horizon at that Time; then bring the Hair A to 12, either at N or S in the 19th Circle, and the Hair B to the abovesaid Hour and Minute of half the Moon's Stay above the Horizon in the same 19th Circle, here screw the Sector fast; with this Opening bring the Hair A to the Moon's Age in the 20th Circle, and the Hair B will shew her setting in the 19th Circle; or bring the Hair B to her Age in the 20th Circle, and the Hair A will cut her rising in the 19th Circle.

The Reason of this Rule is, that Addition and Substraction is performed in any Lines or Circle of equal Parts; see the Description of the 15th and 16th Circles.

Example. I would know the Time of the Moon's rising and setting, *August 5, 1725.*

OPERATION.

First. The last Change Day was *July 28*, therefore on the proposed Day the Moon is 8 Days old, these known, I bring the Hair A to the 28th Day of *July*, in the 11th or 14th Circle, and it cuts the 20th Circle near $26\frac{1}{2}$, where I begin and count 8 Days the Moon's Age, and that Reckoning ends at $4\frac{1}{2}$ in the 20th Circle, and cuts the 9th Circle at 4 H. 22', the Time of the Sun's setting when he hath the same South Declination that the Moon now hath; to this

this I add 12' (for the Reason aforementioned) and the Sum is 4 H. 34', the Moon's Semidiurnal Arch or Half Stay above the Horizon at that Time; then I bring the Hair A to 12 in the 19th Circle, and the Hair B to 4 H. 34' in the 19th Circle (the Moon's Semidiurnal Arch) screw this Opening of the Sector fast, and move the Hair A to the Moon's Age 8, in the 20th Circle, and then doth the Hair B cut the 19th Circle at 10 H. 55', the Time of the Moon's setting that Night; and bring the Hair B to her Age 8 Days in the 20th Circle, and then doth the Hair A cut the 19th Circle at 1 H. 50' after Noon, the same 5th of *August*, the Time of the Moon's rising.

Example, 2. What Time doth the Moon rise and set at *London*, the 18th Day of *October*, 1725?

OPERATION.

The last Change before *October* 18 was on *September* 25, and on the given Day the Moon is 23 Days old; these Things known, lay the Hair A to *September* 25 in the 11th or 14th Circle, and it cuts the 20th Circle at $1\frac{1}{2}$, begin here and count 23 Days, the Moon's Age on the proposed Day, and that Reckoning falls in the 20th Circle at $24\frac{1}{2}$, to which bring the Hair B, and then it cuts the 9th Circle at 8, the Time of the Sun's setting, was he in that Place where the Moon now is; to which I add 12' makes 8 H. 12', half the Moon's Stay above the Horizon on the given Day; then I bring the Hair A to 12, in the 19th Circle, and the Hair B to 8 H.

8 H. 12' in the same Circle, this Opening of the Sector I screw fast, and bring the Hair A to the Moon's Age 23 Days in the 20th Circle, then doth the Hair B cut $2\frac{1}{2}$ in the 19th Circle, the Time of the Moon's setting: Also bring the Hair B to the Moon's Age 23 in the 20th Circle and then doth the Hair A cut $10\frac{1}{2}$ the rising at Night. When the Moon has little or no Latitude, and is in the middle Part of her Orbit, about the conjugate Diameter, then this Rule above will be tolerably true; but when the Moon has near 5° of Latitude, and is near her Perigeon, &c. then it will differ much from the Truth.

And now I have described and shewn the Use of every Circle from the Circumference to the Center; I shall next explain

The Description and Use of Table I.

This Table shews the Dominical Letter and Cycle of the Sun, for one Cycle, or Revolution of the Letter, viz. 28 Years, but may be made perpetual by placing 1748 where 1720 now stands, when these Years in the Table are expired; but to save the Reader that Trouble I shall at the last Page in this Book insert Tables for finding the Dominical Letter in both Accounts by Inspection, beginning with the Year of our Lord 1500, and ending with the Year 2500, being 1000 Years compleat.

Description and Use of Table II.

Of this I have already spoken in the Description of Circle 17, and it being so plain that little
 G needs

needs be said in Explanation. The Table begins with the Year 1720, and ends with 1728, in which is explain'd one Revolution of the Golden Number, and 19 Epacts in the *Julian* Account, with the Letters of Direction before described in Page , and the Tables may be made perpetual by placing the Year 1739 where 1720 now stands, &c. but to save you the Trouble, consult the Tables at the last Page of this Book, where you will find, as by the Description of them, the Golden Number; and not only the Golden Number, but the Epacts in the three most accepted Accounts, viz. the *Julian* or *English* Account; the true Vulgar Foreign or Old Foreign Account; the true *Gregorian* or New Foreign Account for 1000 Years compleat.

Here I must undeceive most of our common Almanack Writers, who hold for a Fundamental Rule, That the *Gregorian* Epact is always so much less than our Epact, as is the Difference of Days in the two Accounts, which they say increase every 100 Years one Day. But you may find, upon further Enquiry, that what they aim at is only the Vulgar Foreign, not the true *Gregorian* Epact; and how far they have and will fall short of the same by the above Rule, the Tables before-mention'd may evince. For from 1700 to 1799 the Difference of Stiles is 11 Days, take any Year within that Compass of Time their said Rule holds good; but in 1800 to 1899 the Difference of Stiles is 12 Days, and the true Vulgar Foreign Epacts being the same as in 1700, &c. if 12 be deducted from the *English* Epact it will give one less than the true Vulgar Foreign, and consequently by using the

the same they will quote false Feasts in that Century as they have done in former Centuries. But I forbear expecting a Reformation for the future.

Description and Use of Table III.

This Table shews the Number of Direction according to the *Julian* Account (as the Tables at the last Page of this Book the Number of Direction in the true *Gregorian* Account) for ever, by entering the Side with the Dominical Letter, and the Bottom with the Golden Number, which you will always find by the two last Tables for the Year proposed. Example, this Year 1732, the *English* Dominical Letters are BA, and the Golden Number is 4, find 4 at the Bottom of this third Table, and the Letter B on the left Hand thereof, if for any Feast that falls before the 25th Day of *February*; but for all the Feasts which happen after the said 25th of *February*, take the Letter A, and in the Place of meeting, if you take B, the Number is 13; but if you take A, the Number is 19; these are called the Number of Directions; and their Use is to find the Moveable Feasts, which are shewed in the 12 Segments of Circles, which I come next to explain.

The Description and Use of the twelve Segments of Circles in the Instrument.

In these 12 Segments of Circles are contained all the Moveable Feasts, with the beginning and ending of *Easter* and *Trinity Terms*, with their

Returns ; the Title of each Segment is a sufficient Explanation, only observe, that every Circle is set under each Word unto which it belongs, and number'd with 10, 20, 30, &c, and dotted 10 35, which Number of 35 they all contain, being the Number of Direction, each Segment being divided into 35, only including those two Days of the Month, between which the Festival falls, and answers to the 12th Circle of Months and Days ; as the Boundary of *Septuagesima Sunday* is *January 18*, and *February 21*, between those two Days inclusive it always falls, as you may see if you lay the Hair of the Sector to the first Dot in its Segment, it will cut *January 18* ; and laid to the last, or 35th Dot, it will cut *February 21* in the 12th Circle ; and likewise the Boundary of *Trinity Term* you will find to be from *May 22* to *June 25*, between those two Days that Term always begins inclusive, and so of all the rest.

Note, When the Number of Direction is 1, you are not to lay the Hair of the Sector at the Line in the beginning of the Segment, which is nothing but the Boundary of that Segment, but to lay it to the first Dot therein, as your Reason will soon direct you.

To find any one, or all the Moveable Feasts in the English Account, with the Terms and their Returns.

Rule, Having found the Number of Direction in the Table for the Year proposed, carry that Number to any of the 12 Segments that has the
Name

Name of the Feast that you are seeking for, and count the Number of Dots equal to the Number of Direction, to which lay the Hair of the Sector, and it will cut the 12th Circle in the Day of the Month that that Feast falls upon.

Example, In the Year 1733, I would know what Day *Septuagesima Sunday*, *Sexagesima Sunday*, &c. falls upon.

First, In Table III. I find the Number of Direction to be 4, this I carry to the Segment of the Circle noted with the Words *Septuagesima*, and to the fourth Dot therein I lay the Hair of the Sector, and it cuts *January 21* in the 12th Circle, the Day that *Septuagesima Sunday* falls on; and by laying the Hair to 4 in the Segment, noted with *Sexagesima-Sunday*, it cuts the 12th Circle in *Jan. 28*; and by applying the Hair of the Sector severally in each Segment to 4 the Number of Direction, I have all the Feasts and Terms for the said Year, as followeth, *viz.*

Septuagesima Sunday, *Jan. 21.*
 Sexagesima Sunday, *Jan. 28.*
 Shrove Sunday, *Feb. 4.*
 Quadragesima Sunday, *Feb. 11.*
 Second Sunday in Lent, *Feb. 18.*
 Third Sunday in Lent, *Feb. 25.*
 Midlent Sunday, *March 4.*
 Fifth Sunday in Lent, *March 11.*
 Palm Sunday, *March 18.*
 Good Friday, *March 23.*
 Easter Sunday, *March 25.*
 Low Sunday, *April 1.*

Quindena Paschæ, *April 9.*

Easter Term begins *April 11.*

Tres Paschæ, *April 16.*

Mense Paschæ, *April 23.*

Rogation Sunday, *April 29.*

Quinque Paschæ, *April 30.*

Crastino Ascensionis, *May 4.*

Easter Term ends, *May 6.*

Whitsunday, *May 13.*

Trinity Sunday, *May 20.*

Crastino Trinitatis, *May 21.*

Trinity Term begins *May 25.*

Octabis Trinitatis, *May 28.*

Quindena Trinitatis, *June 4.*

Tres Trinitatis, *June 14.*

Trinity Term ends, *June 13.*

Example 2. What's the Time of *Easter*, according to the *English* Account, in the Year 1850?

By Table I. I find the Dominical Letter to be A, and by Table II. the Golden Number 8, with which in Table III. I find the Number of Direction to be 33, this I seek in the Segment of the Circle noted with *Easter Sunday*, to which I lay the Hair of the Sector and it cuts in Circle 12 *April 23*, which is *Easter Sunday* that Year.

Note, The same Rule holds for finding the Foreign Feasts, with the *Gregorian* Number of Direction, as with the *Julian*, which brings me to the promised

Descrip-

*Description and Use of the Six Tables at the
last Page of this Book,*

For finding the Cycle of the Sun, Dominical Letter, Golden Number and Epact according to the *Julian* or *English* Account; as also the Dominical Letter, Epact, and Number of Direction in the true *Gregorian* and true *Vulgar* Foreign Accounts, together with the Difference of Days between the said Accounts for 1000 Years compleat; and consequently by these Tables, and the Universal Instrument, the Movable Feasts in both Accounts may be found for any Year within the said Term, by Inspection, *viz.*

- I. TABLE. The First Table shews the Cycle of the Sun from 1500 to 2500 Years.
- II. TABLE. The Second shews the Characteristick for finding the *Gregorian* Dominical Letter, and also the Days Difference in Accounts, *ditto.*
- III. TABLE. The Third shews the Dominical Letter in both Accounts, *ditto.*
- IV. TABLE. The Fourth shews the Golden Number, *ditto.*
- V. TABLE. The Fifth shews the Epact, *ditto.*
- VI. TABLE. And the Sixth shews the *Gregorian* Number of Direction for ever.

To find the Cycle of the Sun.

Rule, Seek for the Centuries in the Side of the First Table, and for the odd Years in the upper Part thereof, and in the Square of these two Numbers you shall find the Cycle of the Sun.

Example, What is the Cycle of the Sun for the Year 1735 ?

First I look for the Centuries, *viz.* 1700, in the Side of Table I. and for the odd Years, *viz.* 35, in the upper Part thereof, and in their common meeting do find the Number 8, which is the Cycle of the Sun.

To find the Characteristick and Days Difference in Accounts.

Rule, Look for the Centuries in the first Column of Table II. and opposite thereto in the second Column is the Characteristick, and in the third is the Days Difference in Accounts.

Example, What is the Characteristick and Days Difference in Accounts for the Century 1800 ?

I answer, by the foregoing Rule, that 3 is the Characteristick, and 12 the Days Difference in Accounts, or Difference of Stiles.

By

*By the Characteristick and Cycle of the Sun
to find the Gregorian Dominical Letter.*

Rule, Look for the Characteristick in the Side of Table III. and the Cycle of the Sun at the Top thereof, and in their common meeting you shall find the *Gregorian* Dominical Letter.

Example, In the Year 1735, Characteristick 2, Cycle of the Sun 8 given, what is the *Gregorian* Dominical Letter ?

First find 2 the Characteristick for 1700 in the Side of Table III. then look for 8 the Cycle of the Sun in the Top of the said Table, and in the Square of their meeting you will see B, which is the *Gregorian* Dominical Letter.

To find the Julian Dominical Letter.

Rule, Search always in the Side of Table III. for the fifth Characteristick, which is marked with this special Note  and the Cycle of the Sun for the Year proposed in the Top of the same, and in their Intersection you shall find the *Julian* Dominical Letter.

Example, What is the *Julian* Dominical Letter for the Year 1735 ?

Find the 5th Characteristick in the Side of Table III. and 8 the Cycle of the Sun in the Top thereof, and where they meet is E the *Julian* Dominical Letter.

To

To find the Golden Number.

Rule, Look for the Centuries in the Side of Table IV. and the odd Years in the upper Part thereof, and in their common meeting you shall find the Golden Number.

Example, What is the Golden Number for the Year 1735?

First I search for the Century 1700 in the Side of Table IV. and for the odd Years, *viz.* 35, in the upper Part thereof, and in the Square of these two Numbers do find 7, which is the Golden Number.

By having the Golden Number to find the Julian Epact.

Rule, Find the Golden Number in the Top Column of Table V. and underneath in the next Column is the *Julian Epact*.

Example, What is the *Julian Epact* for the Year 1735?

Golden Number 7 given; look in the Top Column of Table V. for the Golden Number 7, and underneath in the second Column is 17 the *Julian Epact*.

By

By having the Golden Number to find the Gregorian and Vulgar Foreign Epacts.

Rule, Find the Century for the proposed Year in the Side of Table V. and the Golden Number in the Top thereof, and in their meeting is the *Gregorian Epact*.

Note, Always take the Number 6 from the *Gregorian Epact*, and the Remainder will be the true *Vulgar Foreign Epact*; but if Substraction cannot be made, add 30 to the *Gregorian Epact*, and then deduct as aforesaid.

Example, What is the *Gregorian* and *Vulgar Foreign Epacts* for the Year 1735?

Golden Number 7 given; First I look for the Century 1700 in the Side of Table V. and in the Top thereof for 7 the Golden Number, and in the Square of these two Numbers do find 12, which is the *Gregorian Epact*, from which I take 6 and the Remainder is 6, which is the *Vulgar Foreign Epact*.

By knowing the Gregorian Dominical Letter and Epact to find the Number of Direction.

Find the Dominical Letter in Table VI. on the left Hand, and the Epact at the Bottom, and in the common Angle or Place of meeting is the Number of Direction sought.

Example,

Example, What is the Number of Direction for the Year 1735?

The Dominical is B, which find on the left Hand, and in the Bottom Line find the Epact 12, and in the Place of meeting is 20, the Number of Direction sought.

By the Gregorian Number of Direction to find all the Foreign Feasts.

Rule, Enter the Segment of the Circle in the Universal Instrument with the *Gregorian* Number of Direction for the Feast requir'd, as you have been lately taught to do with the *Julian* Number of Direction, so shall you obtain your Desire.

Example, *Septuagesima* or the next Sunday but one before *Shrove Sunday* is requir'd for the Year 1735?

Number of Direction 20 given; First I look for 20, the *Gregorian* Number of Direction, in the Segment of the Circle noted *Septuagesima*; and by applying one Leg of the Sector to cut the same Number, do find in the the 12th Circle that the Hair of the said Leg is upon the 6th Day of *February*, which is *Septuagesima Sunday*; and by the same Method *Shrove Sunday* will be found to be the 20th Day of *February*, and consequently *Dies Cinerum*, or *Ash-Wednesday*, the 23d, ditto; *Pascha*, or *Easter*, the 10th of *April*; *Ascensio*, or *Ascension-Day*, the 19th of *May*; *Pentecost*, or *Whitsunday* the 29th of *May*, &c.

A TABLE

Table 1 This Table shews the Cycle of the Sun Perpetual.

YEARS		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
		98	99	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
		56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
		84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99												
CENTURYS	2100	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1	2	3	4	5	6	7	8
	1500 2200	25	26	27	28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1600 2300	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1	2	3	4	5	6	7	8	9	10	11	12
	1700 2400	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	1800	17	18	19	20	21	22	23	24	25	26	27	28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	1900	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1	2	3	4
	2000	21	22	23	24	25	26	27	28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Table 2 This Table shews y Char^{ks} for finding y Grego: Domini: Letter together with y Difference of Days in Account

Centurys.....	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Characteristicks	1	1	2	3	4	4	5	6	7	7
Days Diff: in Accou:	10	Bissex	11	12	13	Bissex	14	15	16	Bissex

Table 3 This Table by haueing y Cycle of y Sun and Charac: shews y Gregorian Dominical Letters Perpetually

Cycle of y		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Characteristicks Julian Dom:	1	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D
	2	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E
	3	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F
	4	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G
	5	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A
	6	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B
	7	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C	B	A	G	F	E	D	C

Table 4 This Table shews the Golden Number Perpetually

B. Scott Fecit

YEARS		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
		38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
		57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
		76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
		95	96	97	98	99														
CENTURYS	1500	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	1600	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4
	1700	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8	9
	1800	16	17	18	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1900	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	2000	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5
	2100	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8	9	10
	2200	16	17	18	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2300	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8
	2400	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6

Table 5 This Table shews the Gregorian Epacts for a 1000 Years Compleat.

Gregorian Epacts	Golden Numbers.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Julian Epacts.....	11	22	3	14	25	6	17	28	9	20	1	12	23	4	15	26	7	18	29
	From 1500 to 1699.....	7	18	29	10	21	2	13	24	5	16	27	8	19	1	11	22	3	14	25
	From 1700 to 1899.....	6	17	28	9	20	1	12	23	4	15	26	7	18	29	10	21	2	13	24
	From 1900 to 2199.....	5	16	27	8	19	29	11	22	3	14	25	6	17	28	9	20	1	12	23
	From 2200 to 2299 & 2400 to 2499.....	4	15	26	7	18	29	10	21	2	13	24	5	16	27	8	19	1	11	22
	From 2300 to 2399.....	3	14	25	6	17	28	9	20	1	12	23	4	15	26	7	18	29	10	21

Table 6 The Dominical Letter and Epact found this Table shews the N^o of Direction.

Grego- rian Dominical Letter Perpe- tual	A	33	33	33	26	26	26	26	26	26	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	
	B	34	34	27	27	27	27	27	27	27	20	20	20	20	20	20	13	13	13	13	13	13	13	13	13	13	6	6	6	6
	C	35	28	28	28	28	28	28	28	21	21	21	21	21	21	14	14	14	14	14	14	14	14	14	14	7	7	7	7	7
	D	29	29	29	29	29	29	29	29	22	22	22	22	22	22	15	15	15	15	15	15	15	15	15	15	8	8	8	8	1
	E	30	30	30	30	30	30	23	23	23	23	23	23	23	23	16	16	16	16	16	16	16	16	9	9	9	9	9	9	9
	F	31	31	31	31	31	24	24	24	24	24	24	24	17	17	17	17	17	17	17	17	17	17	10	10	10	10	10	10	3
	G	32	32	32	32	25	25	25	25	25	25	25	18	18	18	18	18	18	18	18	18	11	11	11	11	11	11	11	4	4
Gregorian	Epa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

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A TABLE for converting of Hours and Minutes of Time, into Degrees and Minutes of the Equator., & *contra*.

[illegible]

A Perpetual TABLE of the Sun's Rising and Setting for these Places. -

		Boston New Eng.		Cambridge.			
		Sun rises	Sun sets	Sun rises	Sun sets		
°		h. ' "	h. ' "	h. ' "	h. ' "	°	
The Sun's Declination North.	1	5 56 20	6 3 40	5 55 20	6 5 40	1	The Sun's Declination South.
	2	5 52 24	6 7 36	5 49 24	6 10 36	2	
	3	5 48 56	6 11 4	5 47 36	6 12 24	3	
	4	5 45 12	6 14 48	5 39 16	6 20 44	4	
	5	5 41 28	6 18 32	5 34 0	6 26 0	5	
	6	5 37 48	6 22 12	5 28 48	6 31 12	6	
	7	5 34 0	6 26 0	5 23 28	6 36 32	7	
	8	5 30 16	6 29 44	5 18 8	6 41 52	8	
	9	5 26 28	6 33 32	5 12 44	6 47 16	9	
	10	5 22 36	6 37 24	5 8 20	6 52 40	10	
	11	5 18 44	6 41 16	5 1 40	6 58 20	11	
	12	5 14 48	6 45 12	4 56 12	7 3 48	12	
	13	5 10 52	6 49 8	4 51 32	7 9 28	13	
	14	5 6 56	6 53 4	4 44 48	7 15 12	14	
	15	5 2 2	6 57 8	4 38 56	7 21 4	15	
	16	4 58 44	7 1 16	4 33 0	7 27 0	16	
	17	4 53 36	7 6 24	4 26 52	7 33 8	17	
	18	4 50 20	7 9 40	4 20 36	7 39 24	18	
	19	4 46 0	7 14 0	4 15 16	7 45 44	19	
	20	4 41 40	7 18 20	4 9 12	7 50 48	20	
	21	4 37 8	7 22 52	4 1 0	7 59 0	21	
	22	4 32 36	7 27 24	3 54 0	8 6 0	22	
	23	4 27 56	7 32 4	3 46 52	8 13 8	23	
	23 $\frac{1}{2}$	4 25 32	7 34 28	3 43 8	8 16 52	23 $\frac{1}{2}$	
			Sun sets	Sun rises	Sun sets	Sun rises	

A Perpetual TABLE of the Sun's Rising and Setting for these Places,

		Constantinople.				Copenhagen.					
		Sun rises		Sun sets	Sun rises		Sun sets				
		h. ' "	h. ' "	h. ' "	h. ' "						
The Sun's Declination North.	0									0	
	1	5 56 16	6 3 44	5 54 8	6 5 52	1					
	2	5 52 32	6 7 28	5 48 16	6 11 44	2					
	3	5 48 48	6 11 12	5 42 24	6 17 36	3					
	4	5 45 4	6 14 56	5 36 28	6 23 32	4					
	5	5 41 20	6 18 40	5 30 32	6 29 28	5					
	6	5 37 32	6 22 28	5 24 32	6 35 28	6					
	7	5 34 44	6 25 16	5 18 32	6 41 28	7					
	8	5 29 52	6 30 8	5 12 24	6 47 36	8					
	9	5 26 0	6 34 0	5 6 16	6 53 44	9					
	10	5 22 12	6 37 48	5 0 4	6 59 56	10					
	11	5 18 12	6 41 48	4 53 44	7 6 16	11					
	12	5 14 16	6 45 44	4 47 20	7 12 40	12					
	13	5 11 16	6 49 44	4 40 48	7 19 20	13					
	14	5 6 12	6 53 48	4 34 52	7 25 8	14					
	15	5 2 8	6 57 52	4 27 24	7 32 36	15					
	16	4 57 56	7 2 4	4 20 28	7 39 32	16					
	17	4 53 48	7 6 12	4 13 24	7 46 36	17					
	18	4 49 28	7 10 32	4 6 8	7 53 52	18					
	19	4 45 4	7 14 56	3 59 40	8 1 20	19					
	20	4 41 40	7 19 20	3 50 56	8 9 4	20					
	21	4 36 8	7 23 52	3 42 56	8 17 4	21					
	22	4 31 28	7 28 32	3 34 36	8 25 24	22					
	23	4 26 43	7 33 16	3 25 56	8 34 4	23					
	23 ¹	4 24 20	7 35 40	3 21 28	8 38 32	23 ¹					
		Sun sets	Sun rises	Sun sets	Sun rises						

		Constantinople.				Copenhagen.					
		Sun rises		Sun sets	Sun rises		Sun sets				
		h. ' "	h. ' "	h. ' "	h. ' "						
The Sun's Declination South.	0									0	
	1	5 56 16	6 3 44	5 54 8	6 5 52	1					
	2	5 52 32	6 7 28	5 48 16	6 11 44	2					
	3	5 48 48	6 11 12	5 42 24	6 17 36	3					
	4	5 45 4	6 14 56	5 36 28	6 23 32	4					
	5	5 41 20	6 18 40	5 30 32	6 29 28	5					
	6	5 37 32	6 22 28	5 24 32	6 35 28	6					
	7	5 34 44	6 25 16	5 18 32	6 41 28	7					
	8	5 29 52	6 30 8	5 12 24	6 47 36	8					
	9	5 26 0	6 34 0	5 6 16	6 53 44	9					
	10	5 22 12	6 37 48	5 0 4	6 59 56	10					
	11	5 18 12	6 41 48	4 53 44	7 6 16	11					
	12	5 14 16	6 45 44	4 47 20	7 12 40	12					
	13	5 11 16	6 49 44	4 40 48	7 19 20	13					
	14	5 6 12	6 53 48	4 34 52	7 25 8	14					
	15	5 2 8	6 57 52	4 27 24	7 32 36	15					
	16	4 57 56	7 2 4	4 20 28	7 39 32	16					
	17	4 53 48	7 6 12	4 13 24	7 46 36	17					
	18	4 49 28	7 10 32	4 6 8	7 53 52	18					
	19	4 45 4	7 14 56	3 59 40	8 1 20	19					
	20	4 41 40	7 19 20	3 50 56	8 9 4	20					
	21	4 36 8	7 23 52	3 42 56	8 17 4	21					
	22	4 31 28	7 28 32	3 34 36	8 25 24	22					
	23	4 26 43	7 33 16	3 25 56	8 34 4	23					
	23 ¹	4 24 20	7 35 40	3 21 28	8 38 32	23 ¹					
		Sun sets	Sun rises	Sun sets	Sun rises						

The Sun's Declination South.

A Perpetual TABLE of the Sun's Rising and Setting for these Places.

		Cracovia.		Dantzick.		
		Sun rises	Sun sets	Sun rises	Sun sets	
The Sun's Declination North.	°	h. ' "	h. ' "	h. ' "	h. ' "	°
	1	5 55 12	6 4 48	5 54 28	6 5 32	1
	2	5 50 24	6 9 36	5 48 52	6 11 8	2
	3	5 45 36	6 14 24	5 43 20	6 16 40	3
	4	5 40 44	6 19 16	5 37 44	6 22 16	4
	5	5 35 56	6 24 4	5 32 8	6 27 52	5
	6	5 31 4	6 28 56	5 26 28	6 33 32	6
	7	5 26 8	6 33 52	5 20 44	6 39 16	7
	8	5 21 12	6 38 48	5 15 0	6 45 0	8
	9	5 16 12	6 43 48	5 9 56	6 50 44	9
	10	5 11 12	6 48 48	5 3 20	6 56 40	10
	11	5 6 4	6 53 56	4 57 24	7 2 36	11
	12	5 0 56	6 59 4	4 51 24	7 8 36	12
	13	4 55 44	7 4 16	4 45 16	7 14 44	13
	14	4 51 24	7 8 36	4 39 0	7 21 0	14
	15	4 45 4	7 14 56	4 32 44	7 27 16	15
	16	4 39 36	7 20 24	4 26 16	7 33 44	16
	17	4 34 0	7 26 0	4 19 36	7 40 24	17
	18	4 28 16	7 31 44	4 12 52	7 47 8	18
	19	4 22 28	7 37 32	4 5 52	7 54 8	19
	20	4 16 32	7 43 28	3 58 40	8 1 20	20
	21	4 10 24	7 49 36	3 51 16	8 8 44	21
	22	4 4 8	7 55 52	3 43 36	8 16 24	22
	23	3 57 36	8 2 24	3 35 44	8 24 16	23
	23½	3 54 20	8 5 40	3 31 36	8 28 24	23½
		Sun sets	Sun rises	Sun sets	Sun rises	

The Sun's Declination South.

**A Perpetual TABLE of the Sun's Rising
and Setting for these Places.**

The Sun's Declination North.						The Sun's Declination South.							
			Dublin.				Edenburgh.						
			Sun rises	Sun sets			Sun rises	Sun sets					
°	h.	' "	h.	' "	h.	' "	h.	' "	h.	' "	°		
1	5	54 40	6	5 20	5	54 4	6	5 56			1		
2	5	49 16	6	10 44	5	48 4	6	11 56			2		
3	5	43 56	6	16 4	5	42 4	6	17 56			3		
4	5	38 32	6	21 28	5	36 8	6	23 52			4		
5	5	33 12	6	26 48	5	30 4	6	29 56			5		
6	5	27 32	6	32 28	5	24 0	6	36 0			6		
7	5	21 48	6	38 12	5	18 48	6	41 12			7		
8	5	16 32	6	43 28	5	11 40	6	48 20			8		
9	5	10 52	6	49 8	5	5 28	6	54 32			9		
10	5	5 12	6	54 48	4	59 8	7	0 52			10		
11	5	0 28	6	59 32	4	52 40	7	7 20			11		
12	4	53 40	7	6 20	4	46 12	7	13 48			12		
13	4	47 20	7	12 40	4	39 36	7	20 24			13		
14	4	41 16	7	18 44	4	32 48	7	27 12			14		
15	4	35 36	7	24 24	4	25 56	7	34 4			15		
16	4	29 8	7	30 52	4	18 52	7	41 8			16		
17	4	22 52	7	37 8	4	11 40	7	48 20			17		
18	4	16 28	7	43 32	4	4 16	7	55 44			18		
19	4	9 12	7	50 48	3	56 40	8	3 20			19		
20	4	2 56	7	57 4	3	48 44	8	11 16			20		
21	3	56 12	8	3 48	3	41 36	8	19 24			21		
22	3	50 4	8	9 56	3	32 4	8	27 56			22		
23	3	43 32	8	16 28	3	23 12	8	36 48			23		
23 $\frac{1}{2}$	3	37 4	8	22 56	3	18 36	8	41 24			23 $\frac{1}{2}$		
			Sun sets	Sun rises			Sun sets	Sun rises					

A Perpetual TABLE of the Sun's Rising
and Setting for these Places

		Hanover.				Jerusalem.					
		Sun rises		Sun sets		Sun rises		Sun sets			
		h.	' "	h.	' "	h.	' "	h.	' "		
The Sun's Declination North.	0										0
	1	5	54 48	6	5 12	5	57 28	6	2 32		1
	2	5	49 32	6	10 28	5	54 52	6	5 8		2
	3	5	44 20	6	15 40	5	52 20	6	7 40		3
	4	5	39 4	6	20 56	5	49 48	6	10 12		4
	5	5	34 24	6	25 36	5	47 12	6	12 48		5
	6	5	28 24	6	31 36	5	44 40	6	15 20		6
	7	5	23 4	6	36 56	5	42 0	6	18 0		7
	8	5	17 40	6	42 20	5	39 38	6	20 22		8
	9	5	12 16	6	47 44	5	36 52	6	23 8		9
	10	5	6 44	6	53 16	5	34 12	6	25 48		10
	11	5	1 8	6	58 52	5	31 36	6	28 24		11
	12	4	55 28	7	4 32	5	28 52	6	31 8		12
	13	4	49 44	7	10 16	5	26 0	6	34 0		13
	14	4	43 56	7	16 4	5	23 24	6	36 36		14
	15	4	38 0	7	22 0	5	20 40	6	39 20		15
	16	4	31 56	7	28 4	5	17 56	6	42 4		16
	17	4	25 48	7	34 12	5	15 4	6	44 56		17
	18	4	19 28	7	40 32	5	12 12	6	47 48		18
	19	4	13 0	7	47 0	5	9 20	6	50 40		19
	20	4	6 24	7	53 36	5	6 24	6	53 36		20
	21	3	59 32	8	0 28	5	3 28	6	58 32		21
	22	3	52 28	8	7 32	5	1 20	6	59 40		22
	23	3	45 12	8	14 48	4	57 12	7	2 48		23
	23½	3	41 38	8	18 22	4	55 40	7	4 20		23½
			Sun sets	Sun rises	Sun sets	Sun rises					

A Perpetual TABLE of the Sun's Rising and Setting for these Places.

		Lisbon.		Madrid.			
		Sun rises	Sun sets	Sun rises	Sun sets		
		h. ' "	h. ' "	h. ' "	h. ' "		
The Sun's Declination North.	0						0
	1	5 56 48	6 3 12	5 56 36	6 3 24		1
	2	5 53 36	6 6 24	5 53 16	6 6 44		2
	3	5 50 20	6 9 40	5 49 52	6 10 8		3
	4	5 47 8	6 12 52	5 46 28	6 13 32		4
	5	5 43 56	6 16 4	5 43 4	6 16 56		5
	6	5 41 36	6 19 24	5 39 40	6 20 20		6
	7	5 37 24	6 22 36	5 36 8	6 23 52		7
	8	5 34 8	6 25 52	5 32 48	6 27 12		8
	9	5 31 48	6 29 12	5 29 16	6 30 44		9
	10	5 27 28	6 32 32	5 25 44	6 34 16		10
	11	5 24 24	6 35 36	5 22 16	6 37 44		11
	12	5 20 44	6 39 16	5 18 40	6 41 20		12
	13	5 17 16	6 42 44	5 15 0	6 45 0		13
	14	5 13 38	6 46 22	5 11 24	6 48 36		14
	15	5 10 20	6 49 40	5 7 44	6 52 16		15
	16	5 6 48	6 53 12	5 4 0	6 56 0		16
	17	5 3 12	6 56 48	5 0 12	6 59 48		17
	18	4 59 32	7 0 28	4 56 20	7 3 40		18
	19	4 55 48	7 4 12	4 52 24	7 7 36		19
	20	4 52 4	7 7 56	4 48 24	7 11 36		20
	21	4 48 4	7 11 56	4 44 24	7 15 36		21
	22	4 44 16	7 15 44	4 40 16	7 19 44		22
	23	4 40 20	7 19 40	4 36 40	7 23 56		23
	23½	4 38 20	7 21 40	4 33 52	7 26 8		23½
			Sun sets	Sun rises	Sun sets	Sun rises	

A Perpetual TABLE of the Sun's Rising and Setting for these Places.

		Moscow.		New York.			
		Sun rises	Sun sets	Sun rises	Sun sets		
		h. ' "	h. ' "	h. ' "	h. ' "		
0		h. ' "	h. ' "	h. ' "	h. ' "	0	
1		5 54 12	6 5 48	5 56 24	6 3 36	1	
2		5 48 24	6 11 36	5 52 52	6 7 8	2	
3		5 42 16	6 17 44	5 49 20	6 10 40	3	
4		5 36 44	6 23 16	5 45 44	6 14 16	4	
5		5 30 52	6 29 8	5 42 8	6 17 52	5	
6		5 24 56	6 35 4	5 38 32	6 21 28	6	
7		5 19 0	6 41 0	5 34 56	6 25 4	7	
8		5 13 0	6 47 0	5 31 16	6 28 44	8	
9		5 6 52	6 53 8	5 27 36	6 32 24	9	
10		5 0 44	6 59 16	5 23 56	6 36 4	10	
11		4 54 32	7 5 28	5 20 12	6 39 48	11	
12		4 48 8	7 11 52	5 16 24	6 43 36	12	
13		4 41 48	7 18 12	5 12 32	6 47 28	13	
14		4 35 12	7 24 48	5 8 44	6 51 16	14	
15		4 28 32	7 31 28	5 6 0	6 54 0	15	
16		4 21 44	7 38 16	5 0 22	6 59 38	16	
17		4 14 44	7 45 16	4 56 32	7 3 28	17	
18		4 7 32	7 52 28	4 52 58	7 7 2	18	
19		4 0 8	7 59 52	4 48 36	7 11 24	19	
20		3 51 44	8 7 16	4 46 4	7 13 56	20	
21		3 44 40	8 15 20	4 40 8	7 19 52	21	
22		3 36 28	8 23 32	4 35 44	7 24 16	22	
23		3 28 0	8 32 0	4 31 24	7 28 36	23	
23½		3 23 36	8 36 24	4 28 56	7 31 4	23½	
		Sun sets	Sun rises	Sun sets	Sun rises		

The Sun's Declination North.

The Sun's Declination South.

The Sun's Declination North.

The Sun's Declination South.

A Perpetual TABLE of the Sun's Rising and Setting for these Places,

		Oxford.		Paris.			
		Sun rises	Sun sets	Sun rises	Sun sets		
		h. ' "	h. ' "	h. ' "	h. ' "		
The Sun's Declination North.	0						0
	1	5 54 48	6 5 12	5 55 20	6 4 40		1
	2	5 49 52	6 10 8	5 50 32	6 9 28		2
	3	5 44 44	6 15 16	5 46 16	6 13 44		3
	4	5 39 40	6 20 20	5 41 40	6 18 20		4
	5	5 34 32	6 25 28	5 37 0	6 23 0		5
	6	5 29 20	6 30 40	5 32 20	6 27 40		6
	7	5 24 8	6 35 52	5 27 40	6 32 20		7
	8	5 18 56	6 41 4	5 22 56	6 37 4		8
	9	5 13 36	6 46 24	5 18 12	6 41 48		2
	10	5 7 40	6 52 20	5 13 28	6 46 32		10
	11	5 2 52	6 57 8	5 8 36	6 51 24		11
	12	4 57 24	7 2 36	5 3 40	6 56 20		12
	13	4 51 52	7 8 8	4 58 44	7 1 16		13
	14	4 46 12	7 13 48	4 53 40	7 6 20		14
	15	4 40 28	7 19 32	4 48 36	7 11 24		15
	16	4 34 40	7 25 20	4 43 24	7 16 36		16
	17	4 28 40	7 31 20	4 38 4	7 21 56		17
	18	4 22 44	7 37 16	4 32 40	7 27 20		18
	19	4 16 20	7 43 40	4 27 12	7 32 48		19
20	4 9 56	7 50 4	4 21 32	7 38 28		20	
21	4 3 32	7 56 28	4 15 48	7 44 12		21	
22	3 56 36	8 3 24	4 9 52	7 50 8		22	
23	3 49 36	8 10 24	4 3 44	7 56 16		23	
23½	3 46 8	8 13 52	4 0 40	7 59 20		23½	
	Sun sets	Sun rises	Sun sets	Sun rises			

The Sun's Declination South.	1						1
	2						2
	3						3
	4						4
	5						5
	6						6
	7						7
	8						8
	2						2
	10						10
	11						11
	12						12
	13						13
	14						14
	15						15
	16						16
	17						17
	18						18
	19						19
	20						20

A Perpetual TABLE of the Sun's Rising
and Setting for these Places.

		Rome.		St. Christopher's.			
		Sun rises	Sun sets	Sun rises	Sun sets		
The Sun's Declination North.	°	h. ' "	h. ' "	h. ' "	h. ' "	°	
	1	5 56 24	6 3 36	5 58 44	6 1 16	1	
	2	5 52 40	6 7 20	5 57 28	6 2 32	2	
	3	5 46 48	6 13 12	5 56 12	6 3 48	3	
	4	5 45 36	6 14 24	5 55 0	6 5 0	4	
	5	5 42 4	6 17 56	5 53 40	6 6 20	5	
	6	5 38 24	6 21 36	5 52 24	6 7 36	6	
	7	5 34 48	6 25 12	5 51 8	6 8 52	7	
	8	5 31 8	6 28 52	5 49 52	6 10 8	8	
	9	5 27 24	6 32 36	5 48 32	6 11 28	9	
	10	5 23 40	6 36 20	5 47 16	6 12 44	10	
	11	5 19 56	6 40 4	5 45 56	6 14 4	11	
	12	5 16 8	6 43 52	5 44 36	6 15 24	12	
	13	5 12 20	6 47 40	5 43 16	6 16 44	13	
	14	5 8 24	6 51 36	5 41 56	6 18 4	14	
	15	5 4 28	6 55 32	5 40 36	6 19 24	15	
	16	5 0 32	6 59 28	5 39 16	6 20 44	16	
	17	4 56 28	7 3 32	5 37 12	6 22 48	17	
	18	4 52 24	7 7 36	5 36 28	6 23 32	18	
	19	4 48 12	7 11 48	5 35 4	6 24 56	19	
	20	4 43 56	7 16 4	5 33 36	6 26 24	20	
	21	4 39 36	7 20 24	5 32 12	6 27 48	21	
	22	4 35 12	7 24 48	5 31 44	6 29 16	22	
23	4 30 40	7 29 20	5 29 16	6 30 44	23		
23½	4 28 24	7 31 36	5 28 28	6 31 32	23½		
		Sun sets	Sun rises	Sun sets	Sun rises		

		Rome.		St. Christopher's.			
		Sun rises	Sun sets	Sun rises	Sun sets		
The Sun's Declination South.	°	h. ' "	h. ' "	h. ' "	h. ' "	°	
	1	5 56 24	6 3 36	5 58 44	6 1 16	1	
	2	5 52 40	6 7 20	5 57 28	6 2 32	2	
	3	5 46 48	6 13 12	5 56 12	6 3 48	3	
	4	5 45 36	6 14 24	5 55 0	6 5 0	4	
	5	5 42 4	6 17 56	5 53 40	6 6 20	5	
	6	5 38 24	6 21 36	5 52 24	6 7 36	6	
	7	5 34 48	6 25 12	5 51 8	6 8 52	7	
	8	5 31 8	6 28 52	5 49 52	6 10 8	8	
	9	5 27 24	6 32 36	5 48 32	6 11 28	9	
	10	5 23 40	6 36 20	5 47 16	6 12 44	10	
	11	5 19 56	6 40 4	5 45 56	6 14 4	11	
	12	5 16 8	6 43 52	5 44 36	6 15 24	12	
	13	5 12 20	6 47 40	5 43 16	6 16 44	13	
	14	5 8 24	6 51 36	5 41 56	6 18 4	14	
	15	5 4 28	6 55 32	5 40 36	6 19 24	15	
	16	5 0 32	6 59 28	5 39 16	6 20 44	16	
	17	4 56 28	7 3 32	5 37 12	6 22 48	17	
	18	4 52 24	7 7 36	5 36 28	6 23 32	18	
	19	4 48 12	7 11 48	5 35 4	6 24 56	19	
	20	4 43 56	7 16 4	5 33 36	6 26 24	20	
	21	4 39 36	7 20 24	5 32 12	6 27 48	21	
	22	4 35 12	7 24 48	5 31 44	6 29 16	22	
23	4 30 40	7 29 20	5 29 16	6 30 44	23		
23½	4 28 24	7 31 36	5 28 28	6 31 32	23½		
		Sun sets	Sun rises	Sun sets	Sun rises		

A Perpetual TABLE of the Sun's Rising and Setting for these Places.

		Stockholm.				Vienna.					
		Sun rises		Sun sets		Sun rises		Sun sets			
		h. ' "	h. ' "	h. ' "	h. ' "	h. ' "	h. ' "				
The Sun's Declination North.	°									°	
	1	5 53 12	6 6.48	5 55 32	6 4 28	1					
	2	5 46 28	6 13 32	5 51 4	6 8 56	2					
	3	5 39 40	6 20 20	5 46 48	6 13 12	3					
	4	5 32 38	6 27 22	5 42 8	6 17 52	4					
	5	5 25 56	6 34 4	5 37 32	6 22 28	5					
	6	5 19 0	6 41 0	5 33 4	6 26 56	6					
	7	5 13 8	6 46 52	5 28 36	6 31 24	7					
	8	5 4 56	6 55 4	5 24 4	6 35 56	8					
	9	4 57 48	7 2 12	5 19 28	6 40 32	9					
	10	4 50 32	7 9 28	5 14 28	6 45 32	10					
	11	4 43 16	7 16 44	5 11 0	6 49 0	11					
	12	4 35 40	7 24 20	5 5 4	6 54 56	12					
	13	4 27 56	7 32 4	5 0 4	6 59 56	13					
	14	4 20 8	7 39 52	4 55 16	7 4 44	14					
	15	4 12 4	7 47 56	4 50 12	7 9 48	15					
	16	4 3 52	7 56 8	4 45 24	7 14 36	16					
	17	3 55 16	8 4 44	4 40 16	7 19 44	17					
	18	3 46 28	8 13 32	4 34 40	7 25 20	18					
	19	3 37 20	8 22 40	4 28 12	7 31 48	19					
	20	3 27 48	8 32 12	4 23 48	7 36 12	20					
	21	3 17 52	8 42 8	4 18 12	7 41 48	21					
	22	3 7 20	8 52 40	4 12 24	7 47 36	22					
	23	2 56 12	9 3 48	4 6 32	7 53 28	23					
	23½	2 50 20	9 9 40	4 3 28	7 56 32	23½					
		Sun sets	Sun rises	Sun sets	Sun rises						

A Perpetual TABLE of the Sun's Rising and Setting for these Places.

		Virginia.		Jamaica.		
		Sun rises	Sun sets	Sun rises	Sun sets	
The Sun's Declination North.		h. ' "	h. ' "	h. ' "	h. ' "	
0						0
1		5 56 48	6 3 12	5 58 40	6 1 20	1
2		5 53 40	6 6 20	5 57 24	6 2 36	2
3		5 50 24	6 9 36	5 56 8	6 3 52	3
4		5 47 16	6 12 44	5 54 52	6 5 8	4
5		5 44 36	6 15 24	5 53 28	6 6 32	5
6		5 41 8	6 18 52	5 52 0	6 8 0	6
7		5 38 0	6 22 0	5 50 44	6 9 16	7
8		5 35 0	6 25 0	5 49 20	6 10 40	8
9		5 31 56	6 28 4	5 48 0	6 12 0	9
10		5 27 52	6 32 8	5 46 40	6 13 20	10
11		5 24 36	6 35 24	5 45 20	6 15 40	11
12		5 21 12	6 38 48	5 43 48	6 16 12	12
13		5 17 48	6 42 12	5 42 32	6 17 28	13
14		5 14 24	6 45 36	5 41 0	6 19 0	14
15		5 10 56	6 49 4	5 39 40	6 20 20	15
16		5 7 32	6 52 28	5 38 8	6 21 52	16
17		5 3 52	6 56 8	5 36 44	6 23 16	17
18		5 0 16	6 59 44	5 35 16	6 24 44	18
19		4 57 0	7 3 0	5 33 48	6 26 12	19
20		4 52 52	7 7 8	5 32 12	6 27 48	20
21		4 49 24	7 10 36	5 30 40	6 29 20	21
22		4 46 12	7 13 48	5 29 12	6 30 48	22
23		4 42 52	7 17 8	5 27 28	6 32 32	23
23½		4 39 16	7 20 44	5 26 44	6 33 16	23½
		Sun sets	Sun rises	Sun sets	Sun rises	

The Sun's Declination South.

A TABLE of Amplitudes for these
Latitudes North and South.

Dec.	2	4	6	8	10	12	14
0	0	0	0	0	0	0	0
1	1 0	1 0	1 0	1 0	1 1	1 1	1 1
2	2 0	2 0	2 0	2 2	2 2	2 2	2 2
3	3 0	3 0	3 1	3 1	3 2	3 3	3 4
4	4 0	4 1	4 1	4 4	4 3	4 7	4 9
5	5 0	5 1	5 2	5 5	5 4	5 7	5 10
6	6 0	6 1	6 3	6 5	6 5	6 9	6 13
7	7 0	7 1	7 3	7 5	7 6	7 9	7 13
8	8 0	8 1	8 3	8 5	8 7	8 9	8 13
9	9 0	9 1	9 3	9 5	9 7	9 9	9 14
10	10 0	10 1	10 3	10 6	10 8	10 12	10 18
11	11 0	11 1	11 4	11 6	11 9	11 13	11 17
12	12 0	12 1	12 5	12 7	12 11	12 16	12 22
13	13 0	13 1	13 5	13 7	13 12	13 18	13 26
14	14 0	14 2	14 5	14 9	14 13	14 19	14 26
15	15 0	15 2	15 5	15 9	15 14	15 20	15 28
16	16 1	16 2	16 6	16 10	16 15	16 22	16 30
17	17 1	17 3	17 6	17 10	17 16	17 24	17 32
18	18 1	18 3	18 6	18 11	18 17	18 25	18 35
19	19 1	19 3	19 6	19 12	19 18	19 27	19 37
20	20 1	20 3	20 7	20 12	20 19	20 28	20 38
21	21 1	21 4	21 7	21 13	21 20	21 29	21 40
22	22 1	22 4	22 8	22 13	22 21	22 31	22 42
23	23 2	23 4	23 9	23 15	23 22	23 33	23 44
23 ¹	23 31	23 34	23 38	23 45	23 53	24 3	24 16

A TABLE of Amplitudes for these
Latitudes North and South.

Dec.	16	18	20	22	24	26	28
0	0 /	0 /	0 /	0 /	0 /	0 /	0 /
1	1 2	1 3	1 4	1 5	1 6	1 7	1 8
2	2 4	2 5	2 7	2 8	2 10	2 12	2 15
3	3 5	3 8	3 10	3 13	3 15	3 19	3 22
4	4 11	4 14	4 17	4 21	4 25	4 29	4 34
5	5 12	5 16	5 19	5 23	5 28	5 33	5 39
6	6 14	6 19	6 24	6 29	6 35	6 41	6 48
7	7 16	7 21	7 26	7 32	7 40	7 48	7 56
8	8 17	8 24	8 31	8 38	8 46	8 55	9 5
9	9 20	9 26	9 35	9 43	9 51	10 1	10 12
10	10 24	10 31	10 38	10 48	10 58	11 9	11 21
11	11 27	11 34	11 39	11 53	12 0	12 16	12 30
12	12 30	12 38	12 47	12 59	13 9	13 23	13 37
13	13 32	13 41	13 51	14 3	14 15	14 29	14 45
14	14 55	14 45	14 55	15 8	15 22	15 37	15 55
15	15 37	15 48	16 0	16 14	16 28	16 44	17 3
16	16 40	16 52	17 3	17 18	17 33	17 51	18 10
17	17 42	17 54	18 7	18 24	18 40	18 59	19 21
18	18 46	18 58	19 12	19 29	19 47	20 7	20 29
19	19 47	20 0	20 16	20 33	20 53	21 4	21 38
20	20 50	21 4	21 21	21 39	21 59	22 22	22 47
21	21 54	22 10	22 28	22 46	23 6	23 28	23 55
22	22 56	23 11	23 30	23 50	24 13	24 38	25 7
23	23 58	24 13	24 34	24 56	25 21	25 49	26 18
23 1/2	24 30	24 47	25 7	25 28	25 53	26 20	26 51

A TABLE of Amplitudes for these
Latitudes North and South.

Dec.	30	31	32	33	34	35	36
0	0 /	0 /	0 /	0 /	0 /	0 /	0 /
1	1 9	1 10	1 11	1 12	1 12	1 13	1 14
2	2 17	2 19	2 21	2 23	2 25	2 26	2 28
3	3 26	3 29	3 31	3 34	3 37	3 40	3 43
4	4 39	4 41	4 44	4 48	4 52	4 55	4 57
5	5 46	5 50	5 54	5 58	6 2	6 6	6 11
6	6 57	7 1	7 6	7 11	7 15	7 20	7 25
7	8 5	8 10	8 15	8 20	8 25	8 32	8 40
8	9 15	9 21	9 27	9 33	9 40	9 47	9 54
9	10 24	10 31	10 38	10 45	10 53	11 1	11 9
10	11 34	11 42	11 50	11 58	12 6	12 17	12 24
11	12 44	12 51	12 59	13 8	13 17	13 27	13 38
12	13 53	14 2	14 12	14 22	14 32	14 42	14 53
13	15 3	15 11	15 22	15 33	15 44	15 56	16 4
14	16 13	16 24	16 35	16 46	16 58	17 11	17 24
15	17 23	17 34	17 46	17 59	18 11	18 25	18 40
16	18 33	18 45	18 58	19 11	19 25	19 40	19 55
17	19 44	19 57	20 10	20 24	20 39	20 55	21 11
18	20 54	21 8	21 22	21 37	21 53	22 10	22 27
19	22 5	22 19	22 34	22 50	23 7	23 25	23 44
20	23 16	23 31	23 47	24 4	24 22	24 41	25 0
21	24 25	24 41	25 1	25 19	25 37	25 57	26 18
22	25 38	25 55	26 13	26 32	26 52	27 13	27 35
23	26 49	27 7	27 26	27 46	28 7	28 29	28 53
23 1/2	27 25	27 43	28 3	28 23	28 45	29 8	29 32

A TABLE of Amplitudes for these
Latitudes North and South.

Dec.	37	38	39	40	41	42	43
0	0 /	0 /	0 /	0 /	0 /	0 /	0 /
1	1 15	1 16	1 17	1 18	1 19	1 20	1 21
2	2 30	2 32	2 34	2 37	2 39	2 42	2 44
3	3 45	3 48	3 51	3 55	3 58	4 2	4 6
4	5 0	5 4	5 8	5 13	5 17	5 22	5 28
5	6 16	6 21	6 26	6 32	6 38	6 44	6 51
6	7 31	7 37	7 44	7 51	7 58	8 6	8 13
7	8 47	8 54	9 1	9 9	9 17	9 26	9 35
8	10 2	10 10	10 19	10 28	10 37	10 47	10 58
9	11 18	11 27	11 37	11 47	11 57	12 9	12 21
10	12 33	12 43	12 54	12 6	12 18	13 31	13 44
11	13 49	14 1	14 13	14 26	14 39	14 52	15 7
12	15 5	15 18	15 31	15 45	16 0	16 15	16 31
13	16 22	16 35	16 49	17 5	17 20	17 37	17 55
14	17 38	17 53	18 8	18 25	18 42	19 0	19 19
15	18 55	19 10	19 27	19 45	19 3	19 23	20 44
16	20 11	20 28	20 40	21 5	21 25	21 46	22 8
17	21 28	21 46	22 6	22 20	22 47	23 10	23 34
18	22 48	22 5	23 26	23 48	24 16	24 34	25 0
19	24 3	24 24	24 46	25 9	25 33	25 59	26 26
20	25 21	25 43	26 6	26 31	26 57	27 24	27 53
21	26 39	27 3	27 27	27 53	28 20	28 49	29 20
22	27 58	28 23	28 49	29 17	29 45	30 16	30 49
23	29 17	29 43	30 11	30 40	31 10	31 43	32 17
23 ¹	29 57	30 24	30 52	31 22	31 54	32 27	33 2

A TABLE of Amplitudes for these
Latitudes North and South.

Dec.	44	45	46	47	48	49	50
0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
1	1 23	1 25	1 26	1 27	1 29	1 31	1 33
2	2 47	2 50	2 53	2 56	2 59	3 3	3 7
3	4 10	4 15	4 19	4 25	4 29	4 24	4 40
4	5 34	5 40	5 46	5 52	5 59	6 6	6 14
5	6 58	7 5	7 12	7 20	7 29	7 38	7 48
6	8 21	8 30	8 39	8 49	8 59	9 9	9 21
7	9 45	9 55	10 6	10 18	10 30	10 43	10 56
8	10 9	11 21	11 33	11 46	12 0	12 15	12 31
9	12 33	12 47	13 1	13 16	13 31	13 47	14 5
10	12 58	14 13	14 28	14 44	15 2	15 21	15 40
11	15 22	15 39	15 57	16 15	16 34	16 54	17 19
12	16 48	17 6	17 25	17 45	18 6	18 28	18 52
13	18 14	18 33	18 54	19 15	19 49	19 5	20 29
14	19 39	20 0	20 23	20 46	21 12	21 38	22 6
15	19 5	21 28	21 53	22 19	22 45	23 14	23 45
16	22 32	22 56	23 23	23 50	24 20	24 51	25 24
17	23 59	24 25	24 53	25 22	25 54	26 27	27 3
18	25 26	25 54	26 25	26 50	27 30	28 6	28 42
19	26 54	27 24	27 57	28 30	29 6	29 45	30 20
20	28 23	28 56	29 30	30 6	30 43	32 9	32 55
21	29 54	30 27	31 3	31 42	32 23	33 6	33 53
22	31 24	31 59	32 38	33 19	34 5	34 49	35 39
23	32 54	33 32	34 13	34 57	35 44	36 33	37 26
23 1/2	33 40	34 20	35 2	35 48	36 34	37 26	38 21

A TABLE of Amplitudes for these
Latitudes North and South.

Dec.	51	52	53	54	55	56	57
0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
1	1 35	1 37	1 39	1 42	1 45	1 47	1 50
2	3 11	3 15	3 19	3 24	3 29	3 35	3 41
3	4 46	4 52	4 59	5 6	5 14	5 22	5 31
4	6 22	6 30	6 39	6 49	6 59	7 10	7 22
5	7 58	8 9	8 20	8 31	8 44	8 57	9 12
6	9 33	9 46	10 0	10 14	10 30	10 46	11 3
7	11 10	11 25	11 41	11 58	12 16	12 35	12 56
8	12 47	13 4	13 22	13 41	14 3	14 24	14 48
9	14 24	14 44	15 4	15 26	15 50	16 15	16 42
10	16 1	16 23	16 46	17 11	17 37	18 6	18 36
11	17 39	18 3	18 29	18 56	19 29	19 56	20 29
12	19 17	19 41	20 11	20 42	21 15	21 50	22 27
13	20 55	21 26	21 57	22 30	23 5	23 44	24 24
14	22 36	23 6	23 42	24 18	24 57	25 38	26 22
15	24 17	24 52	25 28	26 7	26 45	27 35	28 22
16	25 58	26 35	27 15	27 58	28 43	29 32	30 24
17	27 40	28 21	29 4	29 48	30 39	31 32	32 28
18	29 24	30 8	30 54	31 43	32 38	33 33	34 34
19	31 9	31 55	32 44	33 38	34 35	35 36	36 42
20	33 45	34 38	35 35	36 37	36 39	37 43	38 54
21	34 42	35 36	36 32	37 34	38 40	39 51	41 11
22	36 32	37 29	38 30	39 26	40 47	42 5	43 27
23	38 3	39 23	40 29	41 40	42 56	43 45	45 50
24	39 19	40 32	41 30	42 43	44 3	45 29	46 55

A TABLE of Amplitudes for these Latitudes North and South.

Dec.	58	59	60
0	0	0	0
1	1 53	1 56	2 0
2	3 47	3 53	4 0
3	5 40	5 50	6 1
4	7 34	7 47	8 1
5	9 28	9 45	10 2
6	11 22	11 42	12 4
7	13 18	13 41	14 6
8	15 14	15 40	16 10
9	17 10	17 40	18 14
10	19 8	19 42	20 19
11	21 6	21 46	22 26
12	23 6	23 48	24 34
13	25 7	25 54	26 44
14	27 10	28 1	28 56
15	29 14	30 11	31 10
16	31 20	32 21	33 27
17	33 29	34 36	35 47
18	35 40	36 52	38 10
19	38 2	39 12	40 37
20	40 12	41 36	43 9
21	42 33	44 5	45 46
22	44 59	46 40	48 31
23	47 30	49 20	51 23
23½	48 48	50 44	52 54

Enter with the Sun's Declination on the Left-Hand, and the Latitude of your Place on the Top, and in the Place of meeting is the Amplitude the Sun has then at that Time and Place, and it is always of the same Name with the Declination, *viz.* North or South. In Page 29, you have the Method of making this Table.





A N

Alphabetical T A B L E

O F

Some of the most Eminent Cities and
Towns in the World, with their
Latitude, and Longitude from *Lon-*
don.

	Lat.	Long.
Aberdeen - - - - -	57 N. 6	1 W. 43
Adrianople, in Asia minor	38 0	31 E. 0
Agra, in India - - -	28 30	78 50
Agaia, in Hungary - -	48 30	19 30
Aleppo - - - - -	35 30	38 0
Alexandria - - - - -	30 30	31 30
Amsterdam - - - - -	52 29	5 15
Antioch - - - - -	35 8	38 0
Antwerp - - - - -	51 20	4 0
Araçta, in Syria - - -	36 0	41 15
Assumption, in Paragu -	25 S. 20	54 W. 20
Athens - - - - -	37 N. 25	24 E. 30
	K	Babylon

	Lat.	Long.
Babylon - - - - -	32 N. 0	45 E. 0
Barbados Isle Middle - -	13 24	61 W. 0
Berwick upon Tweed - -	55 47	1 40
Barcelona - - - - -	40 34	2 E. 0
Bedford - - - - -	52 8	0 W. 30
Bergen, in Norway - -	60 0	5 E. 30
Berlin, in Prussia - - -	52 33	13 30
Bethalem - - - - -	31 49	35 0
Bononia, in Italy - - -	44 30	11 45
Boston, in New England	42 25	70 W. 37
Bourdeaux - - - - -	44 46	0 20
Bridgwater, in Somersetshire	51 10	3 6
Brest, in France - - -	47 58	4 W. 15
Bristol - - - - -	51 30	2 45
Bruges - - - - -	51 17	3 E. 0
Brunswick - - - - -	52 26	10 50
Brussels - - - - -	51 0	4 0
Buda - - - - -	47 40	18 30
Cagliari, in Sardinia - -	39 0	9 30
Calcut, in East India - -	11 10	76 0
Calshot-Castle, in Hampsh.	50 50	1 W. 28
Cambridge - - - - -	52 17	0 5
Canterbury - - - - -	51 18	1 15
Cairo, in Egypt, Cyro -	30 30	31 E. 0
Charles-Town, in Carolina	32 30	81 W. 0
Chester - - - - -	53 10	3 4
Coca, in Florida - - -	33 0	90 0
Compestella, in Spain -	43 6	7 35
Constantinople - - - -	41 6	28 E. 30
Copenhagen - - - - -	55 43	12 0
Cork - - - - -	51 45	9 W. 30
Coventry - - - - -	52 26	1 32
		Cracow,

	Lat.	Long.
Cracow, in Poland - - -	50 N. 10	19 E. 0
Cronton - - - - -	53 22	2 W. 57
Damascus, in Syria - -	32 N. 30	36 E. 0
Dantzick, in Polish Prussia	54 13	19 0
Derby - - - - -	52 55	1 W. 36
Dartmouth, in Devonshire	50 23	4 3
Dover - - - - -	51 10	1 E. 30
Dublin - - - - -	53 20	7 W. 3
Drontham, in Norway -	64 6	10 E. 30
Dunkirk - - - - -	51 2	2 30
Edenburgh - - - - -	56 7	3 W. 0
Ephesus - - - - -	38 30	28 E. 0
Falmouth, in Cornwall -	50 9	5 W. 30
Fee, in New Mexico -	35 0	106 W. 0
Fez, in Barbary - - -	34 30	4 30
Flamborough, in Yorkshire	54 7	0 E. 12
Florence - - - - -	43 40	12 E. 15
Fort St. George, in India	13 0	80 0
Frankfort, on the Main -	50 10	8 0
Frankfort, on the Oder -	52 22	15 0
Geneva - - - - -	46 15	6 45
Ghaunt - - - - -	51 10	3 30
Gibraltar, in Spain - -	36 30	2 W. 0
Glasgow - - - - -	55 50	4 10
Gloucester - - - - -	51 53	2 15
Goures Gutt - - - - -		
Gunfleet, in Essex - -	51 50	1 E. 10
Guernsey - - - - -	49 40	4 W. 30

Hague

	Lat.	Long.
Hague - - - - -	52 N. 20	4 E. 0
Hamburgh, in Denmark -	53 57	10 10
Hanover - - - - -	52 35	9 54.
Harborough, in Leicestersh.	52 30	1 W. 15
Harflew - - - - -	49 40	
St. Helen's, in Isle of Wight	50 N. 40	1 W. 18
Heidelburgh - - - - -	49 N. 30	9 E. 0
Hereford - - - - -	52 4	2 W. 50
Hull - - - - -	53 46	0 15
Jamaica, Island middle -	18 25	75 0
Jerusalem - - - - -	32 30	35 E. 30
James Town, in Virginia	37 47	77 W. 30
Jado, in Japon - - - -	35 0	139 E 30
Kesembazer, in India -	24 0	86 30
Lancaster - - - - -	54 5	2 W. 50
Landaff, in Glamorgansh.	51 34	3 27
Leghorn - - - - -	42 52	11 E. 0
Leicester - - - - -	52 37	1 W. 12
Leith, in Scotland - - -	55 58	3 0
Lepanto, in Greece - - -	37 25	23 E. 0
Liverpoole - - - - -	53 22	3 W. 4
Lima, in Peru - - - - -	11 S. 50	75 20
Lincoln - - - - -	53 N. 15	0 33
Lisbon - - - - -	38 N. 45	8 W. 32
Litchfield - - - - -	52 43	1 54
London - - - - -	51 32	0 0
Leyden - - - - -	52 24	4 E. 0
Lyons - - - - -	47 50	2 0

Madras

	Lat.	Long.
Madras - - - - -	13 N. 0	80 E. 0
Madrid - - - - -	40 10	6 W. 38
Maes - - - - -		
Malden, in Essex - - -	51 44	0 E. 44
Manchester - - - - -	53 32	2 W. 16
Margaret, in Kent - - -	51 24	1 E. 28
Mexico, in New Spain -	19 0	101 W. 15
Mecca, Mahomer's Birth Place	21 30	40 E. 30
Medina, Mahomer buried	24 15	39 30
Milford, in Pembroke-shire	51 43	5 W. 7
Mocha, in Arabia by Red Sea	13 28	42 E. 0
Monomotapa, in Ethiopia	22 S. 30	22 W. 30
Mount Sinai - - - - -	31 N. 0	36 30
Mount's Bay, in Cornwall	50 5	6 E. 0
Moscow - - - - -	55 25	39 E. 30
Naples - - - - -	41 8	14 50
Narbone, in France - - -	43 17	2 30
New Castle upon Tyne - -	54 57	1 W. 22
New York, joyn. to Maryland	41 40	77 0
Nineveh - - - - -	35 50	45 E. 0
Northampton - - - - -	52 50	1 W. 12
Norwich, in Norfolk - - -	52 43	1 E. 16
Nuremburg - - - - -	49 N. 24	11 E. 32
Orfordness, in Suffolk -	52 12	1 E. 26
Orkney Isle - - - - -	60 6	3 W. 30
Orlence - - - - -	47 50	2 E. 18
Ostend - - - - -	51 20	2 45
Oxford - - - - -	51 45	1 W. 15

	Lat.	Long.
Padua, in Italy - - -	45 N. 30	12 E. 0
Paris - - - - -	48 51	2 30
Patavium, in Italy - -	45 6	11 30
Pembroke - - - - -	51 45	5 W. 7
Palermo, in Sicily - -	38 15	14 E. 0
Pekin, alias Quinsey, in China	39 54	115 40
Peterborough - - - -	52 33	0 W. 20
Petersburg, in Russia - -	60 4	39 E. 0
Philadelphia, in Pensilvania	39 0	78 W. 0
Port Royal, in Acadia, Amer.	45 0	63 0
Port Royal, in Jamaica -	17 40	76 0
Portland, joyn. to Dorsetsh.	50 32	2 37
Portsmouth, in Hampshire	50 47	1 12
Prague, in Bohemia - -	50 0	9 E. 0
Presburg, in Hungary -	48 30	17 0
Preston, in Lancashire -	53 48	2 W. 45
Quebec, in Canada - -	46 N. 20	71 W. 0
Ratisbonne, in Germany	48 55	11 E. 40
Red Sea, middle - - -	20 0	39 0
Richmond, in Yorkshire -	54 25	1 W. 37
Roan, in France - - -	49 26	1 E. 28
Rochel - - - - -	46 15	0 W. 58
Rocheſter - - - - -	51 25	0 E. 41
Rome - - - - -	41 50	13 0
Rotterdam - - - - -	52 8	4 0
Salamanca, in Spain - -	41 6	5 W. 15
Salvador, in India - -	21 30	71 E. 54
Salisbury - - - - -	51 4	1 W. 56
Salisburg, in Bavaria -	47 40	13 E. 15
Sardius, in Asia minor -	38 36	36 0
Standeroon, in Scilly -	36 30	36 50
		Seville,

	Lat.	Long.
Seville, in Spain - - -	37 34	5 W. 20
Shoram, in Suffex - - -	50 51	0 14
Shrewsbury - - - - -	52 44	2 50
Southampton, in Hampshire	50 55	1 32
Spire, in Germany - - -	49 17	8 E. 0
Stafford - - - - -	52 50	2 W. 13
Stamford - - - - -	52 37	0 33
Stockholm - - - - -	59 26	17 E. 30
St. Christopher's Isle - - -	17 30	63 W. 0
Surat, in India higher - -	21 30	71 E. 54
Syracuse, in Sicily - - -	37 0	15 7
Tamesware, in Hungary	47 37	20 0
Tarragon, in Spain - - -	40 45	1 20
Theffalonica - - - - -	40 N. 0	28 E. 0
Tinmouth, Northumberland	55 4	1 W. 0
Toledo, in Spain - - -	39 54	3 W. 40
Tombute, in Africa - - -	15 30	0 E. 20
Trent, in Germany - - -	47 20	13 30
Tripoli, in Barbary, Algier	27 0	20 51
Tripoli, in Africa - - -	32 45	13 30
Troy, in Greece - - - -	41 15	26 0
Tunis, in Barbary - - -	36 30	11 15
Turin, in Italy - - - -	44 50	7 15
Valencia, in Spain - - -	39 45	0 W. 20
Venice, in Italy - - - -	45 36	13 E. 0
Vienna - - - - -	48 14	15 15
Ulm, in Germany - - -	48 14	11 24
Ullispo, in Portugal - - -	38 45	8 W. 45
Uraniburg, in Ween Isle	55 54½	13 E. 0
Utrecht, in Holland - - -	52 14	4 30

Warwick

	Lat.	Long.
Warwick - - - - -	52 N. 18	1 W. 38
Warrington - - - - -	53 22	2 41
Weymouth, in Dorsetshire	50 36	2 39
Weymor, in Germany -	51 4	12 E. 46
Wiggan - - - - -	53 34	2 W. 4
Winchelsea, in Suffex -	50 54	0 E. 48
Wittenberg, in Germany -	51 54	14 E. 26
Worms, in Germany - -	49 32	9 24
Wolverhampton - - -	52 38	2 W. 14
Woodstock, in Oxfordshire	51 53	1 23
Wrexham - - - - -	53 6	3 8
Yarmouth, in Isle of Wight	50 41	1 40
Yarmouth, in Norfolk -	52 46	1 E. 40
York - - - - -	53 55	0 W. 57
Zamora, in Spain - - -	41 45	4 W. 48
Zara, alias Sara, in Turkey	44 0	19 E. 20
Zell, in Germany - - -	52 46	10 20
Zuennziga, in Saara Desert	22 0	8 0

The END of the CATALOGUE.



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